LIBRARY AND INFORMATION SERVICES DIVISION

Current References

(91-3)

METEOROLOGY AND OCEANOGRAPHY OF THE MIDDLE EAST

LIBRARY

SEP 9 199

National Marine Fisheries Service
2570 Dole Street
Honolulu, Hawaii

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service
National Oceanographic Data Center

MARCH 1991

METEOROLOGY AND OCEANOGRAPHY OF THE MIDDLE EAST

March 1991

With the outbreak of hostilities in the Arabian Gulf, there has been heightened interest in atmospheric and oceanographic data and information about the Middle East.

This bibliography has been prepared to answer a wide range of questions related to this area. The bibliography is divided into five sections:

I. **Atmospheric Circulation** . . . *page 1*

II. **Desalination** . . . *page 8*

III. **Oceanic Circulation** . . . *page 45*

IV. **Oil and Marine Pollution** . . . *page 69*

V. **Data Distribution Plots** . . . *page 171*

The majority of the information provided in the first four parts is the result of searching the following databases:

Chemical Abstracts Search
Aquatic Sciences and Fisheries Abstracts
Oceanic Abstracts
Pollution Abstracts
National Technical Information Service
GeoRef
Waternet
Biosis
Enviroline
Environmental Bibliography
Pascal
Magazine Index
NewSearch
Newswire
DOE Energy
Water Resources Abstracts

The citations go back as far as 1967 so as to provide a good overview of the literature and data available. Recent news articles have been included on the

massive oil spills due to Operation Desert Storm.

Data sets with information pertinent to the various subject areas (ie. Atmospheric Circulation) have been retrieved from the National Oceanographic Data Center's NEDRES database and incorporated.

Questions about materials cited in the first four sections may be addressed to:

NOAA Central Library
Reference Desk, E/OC4
6009 Executive Boulevard
Rockville, Maryland, 20852

Phone enquiries may be made to (301) 443-8330.

The final section, displaying data distribution plots, represents historical data held by the National Oceanographic Data Center. There are six physical/chemical data types presented.

Questions about this material may be addressed to:

National Oceanographic Data Center
Information Services Division, OC2
1825 Connecticut Avenue, N.W.
Washington, D.C. 20256

Phone enquiries may be made to (202) 673-5549.

I. Atmospheric Circulation

1. ALPERT, P.; A. COHEN; J. NEUMANN, and E. DORON (Hebrew Univ., Jerusalem, Israel)
A model simulation of the summer circulation from the Eastern Mediterranean past Lake Kinneret in the Jordan Valley.
Monthly Weather Review, vol. 110, 1982.
Index terms: Atmospheric circulation/Sea breeze/Summer/Digital simulation/Mathematical model/Mediterranean Sea/Israel

2. ALPERT, P.; B.U. NEEMAN, and Y. SHAY-EL (Tel Aviv University, Israel)
Climatological analysis of Mediterranean cyclones using ECMWF data European Center for Medium-Range Weather Forecasting.
Tellus, Series A - Dynamic Meteorology and Oceanography, vol. 42A, p. 65-77, Jan. 1990.
Geophysical Society of Finland and AMS, Palmen Memorial Symposium on Extratropical Cyclones, Helsinki, Finland, Aug. 29-Sept. 2, 1988)

A thoroughly objective method for the definition, selection and tracing of Mediterranean region cyclones is presented. The method is applied to the ECMWF 1982-1987 analyzed datasets to show monthly cyclone frequencies, cyclonic tracks and vertical variation of average relative vorticity. Day-to-night changes and vertical variation of cyclonic frequencies/vorticities indicate the importance of the sea thermal effect in the eastern Mediterranean. In the western Mediterranean and to a lesser extent in the Cyprus region, the lee cyclogenetic effect is very pronounced. Monthly cyclone tracks are presented and they clearly indicate the preferred routes of cyclonic movements. (Author)
Index terms: CLIMATOLOGY/CYCLONES/MEDITERRANEAN SEA/WEATHER FORECASTING /ATMOSPHERIC CIRCULATION/DIURNAL VARIATIONS/ TEMPERATURE EFFECTS/ VERTICAL DISTRIBUTION/VORTICITY

3. ALPERT, P., and T. REISIN (Tel Aviv Univ., Dep. Geophysics, Ramat Aviv, Israel)
An early winter polar air mass penetration to the Eastern Mediterranean.
Monthly Weather Review, vol. 114, 1986.
Index terms: Mediterranean Sea/Air mass/Penetration/Cold air/ Winter/ Case study/Atmospheric circulation

4. BIDLEMAN, T.F., and R. LEONARD (South Carolina, University, Columbia, SC)
Aerial transport of pesticides over the Northern Indian Ocean and adjacent seas.
Atmospheric Environment, vol. 16, no. 5, p. 1099-1107, 1982.

Between 1976 and 1978, airborne organochlorines were measured over the northern Indian Ocean and the North Atlantic. Shipboard measurements in the Indian Ocean were made in the equatorial and northern Arabian Sea, the Persian Gulf and the Red Sea. In the North Atlantic samples were collected at Barbados, the southern tip of Newfoundland, and from shipboard on a cruise across the trades region. Collections were made by pulling air through a glass fiber filter followed by a column of polyurethane foam. Analyses were done by packed and glass capillary gas chromatography using electron capture detection. The most striking difference in organochlorine patterns between the two oceans is the much higher DDT concentrations over the eastern seas. Average DDT levels in the Arabian Sea-Persian Gulf-Red Sea area were 25-40 times the 3.0 pgm North Atlantic background value. These higher levels most likely result from the continued use of DDT in countries bordering these areas. By contrast, DDT use in the United States, Canada and most northern European countries has ceased. The most prevalent chlorinated pesticides over the North Atlantic were chlordane and polychloroterpenes, both of which are still used in the United States. ((Author))
Index terms: AIR POLLUTION/ATMOSPHERIC CIRCULATION/MARINE ENVIRONMENTS/ PESTICIDES/POLLUTION TRANSPORT /AIR SAMPLING/ CHLORINE COMPOUNDS/GAS CHROMATOGRAPHY/INDIAN OCEAN/ ORGANIC COMPOUNDS

5. **Distribution of Thunderstorms and Lightning over the Eastern Hemisphere, 1972,**
Jan. - Oct. 1972.
Geographic Area - South, West, and Central Africa, North Africa, Mediterranean Sea, North and South Eurasia, Arabia, North and South India, Japan and Southeast Asia.

An attempt was made to determine the distribution of thunderstorms and lightning and incidence of lightning discharge over the eastern hemisphere for 1972. Data were collected by Air Force personnel using Sferic sensor at 150,000 datum points. Lightning and thunderstorm data are presented by latitude and longitude and charts give distributions in isolines.

6. GRILLAKI, D., and S. PIACSEK (SACLANT ASW Research Center, La Spezia (Italy))
Numerical simulations of the circulation of the eastern Mediterranean. 1985. 30 p.
Report #: AD-A170219; SACLANTCEN-SR-92 Available from NTIS.

Oceanographic observations have shown that the surface circulation in the eastern Mediterranean consists of the zonal North African Current along with systems of gyres and rings both north and south of the Current. A large cyclonic gyre occurs between Cyprus and Crete, and another between Greece and Libya. A weaker, quasi-permanent eddy is formed in the Ionian sea and is intensified by the flow through the Strait of Sicily. An anticyclonic ring occurs south of the North African Current in the Gulf of Sirte and another occurs in the southwest Levantine Sea. The reduced-gravity model (one active layer) of Hurlburt and Thompson has been adapted and applied to the semi-enclosed basin of the eastern Mediterranean. Using monthly averages of climatological wind stresses and the estimate of the annual mean flow through the Strait of Sicily, numerical simulations of the circulation in the eastern Mediterranean basin have been carried out. Model runs both with and without inflow through the Straits have been performed. The overall results agree with the observations. They show the presence of the North African Current, two persistent cyclonic gyres of varying strengths and two anticyclonic rings. (GRA)
Index terms: ATMOSPHERIC CIRCULATION/MEDITERRANEAN SEA/OCEAN CURRENTS/ OCEAN MODELS /CYPRUS/GREECE/LIBYA/MATHEMATICAL MODELS/ NUMERICAL ANALYSIS/SICILY/ STRAITS/THERMODYNAMIC PROPERTIES

7. Hopkins, T.S. (Brookhaven National Lab., Upton, NY.)
Discussion of the Ionian and Levantine Seas, NATO Workshop on Atmospheric and Oceanic Circulation in the Mediterranean Basin. NATO workshop on atmospheric and oceanic circulation in the Mediterranean Basin.
Washington, DC. : Department of Energy, 1983. 42 p.
NTIS report number: DE84-011562.

The Levantine Intermediate Water (LIW) is the most critical water mass in the thermohaline heart of the Mediterranean. It is comprised of North Atlantic Water (NAW) which was transformed to salty water (36.2 to 39.2 ppt). In the eastern Mediterranean (EMED) the NAW changes to a warm saline surface layer and a cool

less saline layer. Much of the LIW is produced from winter cooling of surface waters. The distribution is patchy, dependant on original surface type, circulation, and atmospheric exposure. Convective depths range to 400 m; the densest water not necessarily correlated with the deepest convective layers. Survival of the LIW depends on circulation and density. The circulation of the EMED is barotropically controlled by sea level. The annual low frequency signal is a trough extending zonally south of center and deepening eastward. The resulting cyclonic circulation is skewed to the south and east. The westerly winds exaggerate the African eastward coastal flow. Wind stress, positive curl in northern Levantine and negative curl in the Gulf of Sirte, contribute to the circulations. Higher frequency variations in water loss impose barotropic noise on the lower-frequency pattern; higher frequency wind energy affects surface circulations and deeper barotropic flows. The internal pressure gradient, resulting from the denser LIW, causes the westward return flow on the northern side within the LIW layer. The deep layers lack potential to drive baroclinic shear; consequently, they react to any unadjusted barotropic pressure gradients. This is substantial even at low frequencies. Deep Water tends to follow the basic barotropic pattern, flowing eastward along the African coast beneath the NAW. 22 references, 11 figures. (ERA citation 09:031698)
Index terms: Mediterranean Sea/Evaporation/Salinity/Temperature Gradients/Water Currents/Wind/Barotropic waves

8. Makrogiannis, T.J., and ChS. Sahsamanoglou (Met. Inst., Aristotelian Univ., Thessaloniki, Greece)
Anomalous atmospheric circulation favouring snowfall in northern Greece.
Journal of Meteorology, Trowbridge, Eng., vol. 6, no. 61, p. 225-230, Sept. 1981.

The authors present atmospheric circulation over Europe and the North Atlantic during cases of snowfall over northern Greece. On the basis of mean charts of a sample consisting of 70 such cases in this area, and through the process of anomalies, it is found that, two days before the snowfall, a warm transport on the North Atlantic, which is reinforced with time, produces an intense meridional circulation in the area of Europe on the day of the snowfall. Surface pressure systems responsible for the phenomenon are moving highs over central and western Europe on the day of the snowfall and Mediterranean depressions centered on

the same day over the eastern Mediterranean.
Index terms: Atmospheric circulation-snowfall relationships/ Synoptic conditions for snowfall/Europe/Greece

9. METAXAS, D.A. (Ioannina, University, Ioannina, Greece.)
Strong cold outbreaks in the East Mediterranean - A synoptic study.
Rivista di Meteorologia Aeronautica, vol. 38, p. 95-105, Apr.-June 1978.
Scuola Internazionale di Fisica dell'Atmosfera, Corso, Erice, Sicily, May 16-31, 1976.

Three characteristics of the Eastern Mediterranean area are stressed: (1) the fact that it is south of the westerlies, (2) the fact that it is a powerful heat source and cyclogenesis area during cooler periods, and (3) its ragged orography. The synoptic structure and evolution of strong cold outbreaks in the months of January, April, and October is examined. (B.J.)
Index terms: ATMOSPHERIC CIRCULATION/COLD FRONTS/COLD WEATHER/ MEDITERRANEAN SEA/SYNOPTIC METEOROLOGY /AIR MASSES/CYCLOGENESIS/

10. MICHAELIDES, S.C. (Univ. Reading, Meteorology Dep., Reading, United Kingdom)
Components of large-scale kinetic energy generation during an eastern Mediterranean cyclogenesis.
Archives for meteorology, geophysics, and bioclimatology. Series A: meteorology and geophysics, vol. 32, 1983.
Index terms: Atmospheric energy/Kinetic energy/Large scale/ Generation/ Cyclogenesis/Mediterranean Sea/Atmospheric circulation

11. OTTERMAN, J. (Tel Aviv University, Tel Aviv, Israel)
Observations of wind streaklines over the Red Sea from the ERTS-1 imagery.
Remote Sensing of Environment, vol. 4, no. 1, p. 79-94, 1975.

Observations are reported of differences in radiance levels over the Red Sea in the scanner imagery from the Earth Resources Technology Satellite, now called Landsat-1. Two types of effects are observed: narrow streaks of lower radiance extending for up to 100 km leeward from islands or mountains near the shore (referred to as lee-lines); and striations of alternate darker and lighter bands, each up to 1 km broad. Two interpretations

are discussed, of local sea-state differences and of local differences in the dust levels in the atmosphere. In the sea-state differences interpretation, the darker regions correspond to a lower sea-state linked to lower wind velocity. However, objections can be raised to the sea-state differences interpretation and it is suggested that the dust level differences in the atmosphere offer the correct interpretation. ((Author))
Index terms: LANDSAT SATELLITES/PHOTOINTERPRETATION/RED SEA/ REMOTE SENSORS/SEA STATES/WIND (METEOROLOGY)

12. PICON, LAURENCE (CNRS, Laboratoire de Meteorologie Dynamique, Palaiseau, France.)
Comparisons between Meteosat water vapour radiance and ECMWF analysed fields for July 1985.
Conference on Satellite Meteorology and Oceanography, 4th,.
Boston, MA, : American Meteorological Society, 1989. p. 202, 203.
Preprints (A90-30126 12-47).

The interpretation of water-vapor radiances in terms of circulation parameters is examined. Three of the analyzed areas are located in subtropical regions, while the fourth is located in the ITCZ. For the comparison study the analysis of the ECMWF archives are used. The analyzed parameters are temperature, relative humidity, vertical velocity, divergence, and geopotential. The examination of mean dynamic fields shows that the strong WV radiance areas are almost always a subsidence zone in the middle troposphere, that a divergence zone is near the surface, and that a convergence zone is at the top of the atmosphere. Nevertheless, a strong regional variability is present: the temperature and pressure effect is dominant over the maritime anticyclones, while the humidity and vertical velocity effect is dominant over the Eastern Mediterranean. (N.B.)
Index terms: ATMOSPHERIC CIRCULATION/ATMOSPHERIC MOISTURE/ INFRARED RADIOMETERS/METEOSAT SATELLITE/SATELLITE IMAGERY

13. TRITAKIS, V.P. (Acad. Athens, Res. Cent. Astronomy Applied Mathematics, Athens, Greece.)
Possible solar signature on a well-estasblished weather phenomenon.
JGR. Journal of Geophysical Research. D. Atmospheres, 89 1984.
Index terms: Solar terrestrial relation/Atmospheric circulation/ Greece/East Mediterranean/11 year-Cycle/Winds/Anticyclonic eddy

II. Desalination

1. **215 mil for construction of a desalination and peace plant in Saudi Arabia coast.**
Arab Times, p. 14, Feb. 20, 1985.

Saudi Arabia has signed contract worth $215 mil for construction of a desalination and power plant at Shuqeiq in south-western Saudi Arabia on the Red Sea, an industry source in Riyadh said Tue Feb 19. A $ 128 mil contract went to 2 subsidiaries of the Paris-based Sogex group of cos, Pegel Arabia and Envirogenics Systems, to build a 20 mil gallon per day desalination plant, the first in the south-west of the country. A $ 87 mil contract to build a 128-mw power station was signed with a consortium led by Hitachi Zosen Corp of Japan and including General Electric Company of the USA and Japan's Penta Ocean. The contracts were awarded by the govt's Saline Water Conversion Corp. Work has already begun on pipelines to carry the water to towns high up in the Aseer mountains and on the Red Sea.
Index terms: Saudi Arabia/Industry--Water Industry/Tenders

2. Abdul-Fattah, A. Foad (Univ of Riyadh, Saudi Arabia)
SITING OF NUCLEAR DESALINATION PLANTS IN SAUDI ARABIA BASED ON VERBAL JUDGMENT.
Atomkernenergie/Kerntechnik, vol. 40, no. 4, p. 282-285, 1982.

Site selection of nuclear desalination plants in the Kingdom of Saudia Arabia is a complex task since it depends on many interrelated factors. Two candidate sites are considered, one near Jeddah-a major port on the Red Sea and the second on the Arabian Gulf near Dhahran. Using verbal judgment, the fuzzy set theory and the MAFDA computer code are employed to examine the most suitable site. Thirteen main criteria were considered for the selection. The final results show that the site near Dhahran is preferred to Jeddah for the first nuclear desalination plant in Saudi Arabia. 23 refs.
Index terms: NUCLEAR POWER PLANTS--Site Selection/DESALINATION/ MATHEMATICAL TECHNIQUES--Fuzzy Sets

3. **Agriculture Minister: Desalination costs SR 1.5 per cubic metre.**
Arab News, p. 2, April 8, 1989.

Saudi Agriculture and Water Min, Dr. Abdul Rahman Sheikh stated in Riyadh, Friday, April 7 that the production cost of desalinated seawater has come down to SR 1.5 per cu m. "This is equal to or less than the cost of producing the same quantity of underground water," he added. Saudi Arabia has become the world's largest producer of desalinated water, the min said. He added that the total capacity of desalination plants spread along the country's western and eastern coasts has reached more than 500 mil gallons per day. These plants also supply 3,400 mw of electricity, he noted. There are 23 operational desalination plants in the country, 17 on the Red Sea and 6 on the Arabian Gulf. Sheikh said the Kingdom has now achieved self-sufficiency in desalinated water for drinking purposes in the main cities and townships. For agricultural purposes, underground water is now being supplied in adequate quantities
Index terms: Saudi Arabia/Industry--Water Industry/Energy--Electric Power/Production/Profiles/Statements

4. Akkad, A.A.Al-Homoud, A.; Hamdan, L.S.; Hamdan, I., and Abdel-Jawad, M.M. (Dep. Islamic and Arabic Stud., King Fahd Univ. Pet. and Miner., 31261-Dhahran, Saudi Arabia.)
Water conservation in arid and semi-arid regions. Desalination Proceedings of the Kuwait Symp. on Management and Technology of Water Resources in Arid Zones, 1989. pp. 185-205

In the last decade the per capita water consumption in the Arabian Gulf Countries has increased dramatically. To meet the higher rate o consumption, various viable water alternatives such as desalination, reclamation of treated wastewater, exploitation of groundwater resources and proper management of surface water supplies are being sought in these countries. It has been estimated that the cost of production per cubic meter of desalinated water in this region is in the range of Saudi Riyals (SR) 4-11. Considering this high cost and also taking into account the depletion of groundwater resources through "mining" practices, it has become necessary to improve the utilization and management of water resources through conservation. This paper discusses the physical, economic, and technical means of water conservation and their effectiveness under the socia-cultural conditions of the Arabian Gulf Countries.
Index terms: desalination/water conservation/arid environments/economics/production cost/water reclamation/wastewater treatment/water management /Arabia, Persian Gulf area

5. Al Ghamdi, M.F.; C.H. Hughes, and S. Kotake (Saline Water Convers. Corp., Jeddah, Saudi Arabia)
The Makkah-Taif MSF desalination plant.
3. World Congress on Desalination and Water Reuse, 1987.
p. 3-10.

The most modern and one of the largest power and desalination plants in the world is presently under construction at Shoiba on the Red Sea coast in Saudi Arabia and is scheduled to be commissioned in the middle of 1987. This paper outlines main design features and construction of the desalination plant.
Index terms: desalination plants/construction/design /ISW, Saudia Arabia, Shoiba

6. Al-Gholaikah, A.; N. El-Ramly; I. Jamjoom, and R. Seaton (Ministry of Agriculture and Water, Water Affairs, Riyadh, Saudi Arabia)
The world's first large seawater reverse osmosis desalination plant, at Jeddah, Kingdom of Saudi Arabia.
DESALINATION, vol. 27, no. 3, Dec. 1978.

Traditionally, coastal urban centers in arid regions have had to rely on distillation as the means of desalting seawater. A new technique for desalting seawater is exemplified by the current installation of a large reverse osmosis plant to desalt highly saline Red Sea water to supply municipal water needs at Jeddah, Saudi Arabia. The Saline Water Conversion Corporation of the Kingdom of Saudi Arabia awarded a competitive bid contract to Fluid Systems Division of UOP Inc. for the design, fabrication, construction and 2-yr operation and maintenance of a seawater reverse osmosis desalination plant with a production capacity of 12,000 m3/d. A comprehensive review and description of the design, logistics and installation aspects of the plant together with an evaluation of delivery times and capital and operating costs of reverse osmosis vis-a-vis multiflash distillation for seawater desalination are presented.
Index terms: Desalination methods/Desalination plants/Red Sea/ Reverse osmosis/ Saudi Arabia Coast/Design/Economics /Jeddah

7. Al-Golaikah, M.A. (Saline Water Conv. Corp., P.O. Box 5968, Riyadh 11432, Saudi Arabia)
Desalination by the Saline Water Conversion Corporation of Saudi Arabia.

DESALINATION, vol. 50 1984.

Lying between Al-Khafji and Al-Khobar is Al-Jubail, site of SWCC's largest desalination plant which is also the largest in the world. Phase I, at 36.3 mgd and 360 MW, began supplying water to the port of Al-Jubail and the industrial complex being built there, in 1401 H (1981). Phase II, with 253.5 mgd/1295 MW capacity, is now fully operable. It began supplying water to Riyadh, the capital city, through twin 60 in. diameter pipelines 466 km, long, in 1403 H (1983). Total SWCC production along the Gulf, including one plant under construction is approximately 355 mgd (plus 2255 MW of power). This amount, added to that along the Red Sea, establishes Saudi Arabia as the world's largest users of potable water from the sea .
Index terms: desalination plants/industrial production/Saudi Arabia

8. Al-Mutaz, I.S. (Chem. Eng. Dep., King Saud Univ., P.O. Box 800, Riyadh 11421, Saudi Arabia)
By-product recovery from Saudi desalination plants.
3. World Congress on Desalination and Water Reuse, 1987. p. 97-110.

Saudi Arabia has the largest capacity of desalination inventory in the world. Desalination in Saudi Arabia account for approximately 50% of the world capacity. In these massive desalination plants, huge amounts of drained brine are disposed. Besides the large flow rates of the disposed brine, sea water intakes in Saudi Arabia, Red Sea and/or Arabian Gulf, have the maximum salinity in the world. This increases the amount of the dissolved minerals in the desalination blow-down. The use of drained brine in appropriate processes can yield magnesium, calcium, potassium, chlorine and bromine as well as salt, sodium chloride. The possible production of some by-products from Saudi desalination plants will be discussed in this paper together with the technical feasibility of the proposed processes.
Index terms: byproducts/brines/desalination /Saudi Arabia

9. Al-Mutaz, I.S., and M.I. Al-Ahmed (Chem. Eng. Dep., King Saud Univ., P.O. Box 800, Riyadh 11421, Saudi Arabia)
Evaluation of solar powered desalination processes.
4. World Congress on Desalination and Water Reuse. VOLUME 2: OPERATIONAL EXPERIENCE -- SEAWATER RO; RESEARCH AND DEVELOPMENT -- EVAPORATIVE. 1989, p. 181-190

Besides the conventional thermal distillation process, other desalination processes have been possible by the application of the active utilization of solar energy. These processes include electrodialysis, reverse osmosis, freezing, ... etc. Undoubtedly, solar desalination is considered the best alternative to provide fresh water in remote arid areas. The selection of the appropriate solar desalination process is a unique problem ever done by processes comparison. In this paper, the evaluation of the possible solar desalination processes will be carried. The Arabian Gulf region will be used as a reference for the evaluation study. Comparison with the fossil fuel powered desalination plants will also be presented to justify the recommendation of the selected solar desalination process.
Index terms: desalination/solar radiation/electrodialysis/reverse osmosis/freezing/evaluation/comparative studies/fossil fuels/ISW, Persian Gulf

10. Al-Shatti, I. (Coll. Technol. Stud., Kuwait)
Towards the use of industrial wastewater for irrigation in Kuwait.
DESALINATION, vol. 72, no. 1-2, 1989.
Proceedings of the Kuwait Symp. on Management and Technology of Water Resources in Arid Zones, Kuwait, Oct. 5-7, 1987.

This paper focuses on the industrial wastewater discharged into the Gulf in the Shuaiba Industrial Area (SIA). The disposal of waste from vital industrial activities is causing coastal pollution threatening the environment, and the supply to desalination plants. The shortage of irrigation water has led to a search for methods of reusing desalinated water. The Kuwait Institute for Scientific Research (KISR) and the Shuaiba Area Authority (SAA) have made a joint research study to protect marine ecology from industrial pollutants. Among their recommendations was the alternative of using such water for irrigation. The quality of the water, as indicated, presents no obstacles. However the duration and the quantity of flows were not discussed. This paper discusses the possibility of adding such a source to the allocated amounts for irrigation, based on time series analysis of the quantities of industrial wastewater delivered from Shuaiba Refinery (SR). The paper also suggests future work to capture the amounts of water releases below the industry.
Index terms: industrial wastes/pollution control/ISW, Kuwait, Shuaiba/ISW, Persian Gulf/marine pollution/pollution effects/

wastewater treatment/desalination plants

11. Al-Sofi, M.A. K.; S. Khalaf, and A. Al-Omran (P.O.B. 752, Al-Khobar 31952, Saudi Arabia.)
Practical experience in scale control.
4. World Congress on Desalination and Water Reuse; VOLUME 2: OPERATIONAL EXPERIENCE -- SEAWATER RO; RESEARCH AND DEVELOPMENT -- EVAPORATIVE. 1989, p. 313-325

To date the primary desalination process deployed along the Persian Gulf is Multi-Stage Flash (MSF) evaporation. MSF performance relies primarily on heat transfer between vapour and brine solution along a temperature range of 25-121 degree C. Almost all MSF evaporators in this region are operated by brine recirculation to improve efficiency and thus reduce cost. Yet recirculation mandates heat transfer with concentrated sea water solution. Due to the concentrated nature of the heat transfer medium, scaling is the most critical factor controlling MSF productivity, especially upper half of the said temperature range. Scale formation cannot be eliminated, but it can be combatted. It is particularly essential to minimize scale formation on heat transfer surfaces i.e. tubes inner surfaces. Minimum scale presence in tubes is achieved by either formation prevention or removal.
Index terms: desalination plants/distillation/scaling/control/ sulfuric acid/chelates/maintenance/ISW, Persian Gulf/multi-stage flash

12. Ali, M.Y., and J.P. Riley (Environ. Prot. Dep., Minist. Public Health, Kuwait)
The distribution of halomethanes in the coastal waters of Kuwait.
MAR. POLLUT. BULL, vol. 17, no. 9, p. 409-414, 1986.

Chlorination of sea water used as cooling and feed water in the combined desalination-power plants of Kuwait leads to the formation of appreciable quantities of halomethanes. Significant concentrations of these compounds (up to 90 mu g l super(-1) as total haloforms) are present in the sea in the immediate vicinity of the out-falls from these plants. Beyond the point of discharge, the distributions of these compounds are consistent with the hydrography of the area, concentrations falling to below the detection limit (0.1 mu g l super(-1)) within a few kilometres as a result of mixing and evaporation. Bromoform

generally accounts for 95% of the total halomethanes, almost all of the remainder being dibromochloromethane.
Index terms: pollution monitoring/chemical pollution/spatial distribution/coastal waters/marine pollution/halogenated hydrocarbons /ISW, Persian Gulf/ISW, Kuwait /halomethanes/ bromoform/dibromochloromethane

13. Ali, Mahood Y.; Riley, J.P.
The production of brominated methanes in desalination plants in Kuwait.
Water Research, v. 23, p.1099-106, September 1989.

14. Ali El-Saie, M.H., and Y.M. H. Ali El-Saie (Consulting Engineers, Heliopolis, Cairo, Egypt)
Optimization of dual-purpose steam power and MSF desalination plant.
Desalination, vol. 76, no. 1-3, p. 155-175, Nov. 1989.

One of the main targets in the design stage of a dual-purpose steam power and large multistage flash desalination plants of known outputs is the determination of the lowest performance ratio for the desalination plant to ensure lower capital and operating costs, after selection of the system, based on thermodynamic and economic comparisons. After determining the best size and performance ratio of the desalination units, the following elements were considered for the calculation of the water production cost: capital cost of the plant including civil engineering, cost of heat, cost of electricity, cost of chemicals, plant economic life, interest rate, and utilization factor of the plant. A preliminary study for a 400 megawatt steam power and 48 million imperial gallon/day plant for Abu Dhabi, Arabian Gulf was conducted. The main concern was to determine the lowest performance ratio of the desalination plant. Sensitivity analyses showed that if cost of heat was doubled, then an optimum performance ratio of 7 was recommended provided enough steam was available from the turbines. The unit capacity of 7/8.4 million imperial gallons/day gives the most economic solution/ However, this capacity is about 17% bigger than units currently in commercial production. With good specification and control during the design stage and a prototype test or mathematical analysis, there should be no risk on having a reliable unit plant of 7/8.4 million imperial gallons/day.
Index terms: cost analysis/desalination plants/electric power/ electric power costs/multistage flash distillation/thermal powerplants/electric power production/optimization/Persian Gulf/

15. Anon.
SAUDI ARABIA SWCC AL-JOBAIL POWER & DESALINATION PLANT PHASE II.
Technical Review - Mitsubishi Heavy Industries, vol. 21, no. 2, p. 157, Jun 1984.

This project relates to a power and desalination plant adjoining to the Al-Jobail Industrial Area on the Persian Gulf side of Arabian Peninsula. The plant has a daily desalination capacity of about 1,000,000 tons of water and power generation capacity of about 1,300 MW, and is capable of transporting the desalinated water to Riyadh, about 500 km distant from the plant, through the pipeline. The order of this power and desalination plant was placed by the SWCC (Saline Water Conversion Corporation, Ministry of Water and Agriculture) to five Japanese companies. The principal structures and characteristics of the project are outlined.
Index terms: POWER PLANTS--Saudi Arabia/WATER TREATMENT PLANTS--

16. Anon.
Solution to Saudi water supply problem.
Construction Repair, vol. 3, no. 7 p. 35, Sep 1989.

Since 1976, Saudi Arabia's desalination plants have worked non-stop to supply water for all needs, but, after ten years' operation, the aggressive marine environment has taken a heavy toll. Worst affected were the reinforced-concrete structures immediately adjacent to the Red Sea. The solution required a special system of repair. The repair method and system chosen involved breaking our all defective concrete and cleaning the reinforcing steel by sand-blasting. In some cases, badly corroded steel bars were replaced. Nitoprime Zincrich was applied to all steel reinforcement, both old and new. Nitobond EP was used as a bonding aid and, equally importantly, as a barrier coat to prevent migration of residual chloride ions from the host concrete back into the new repair areas. After the erection of formwork, pre-packed cementitious micro-concrete, incorporating special aggregates, was mixed and poured into place. The formwork was left in place for about ten days. Critical areas were subsequently treated with a final layer of external protection.
Index terms: CONCRETE CONSTRUCTION--Repair/WATER

TREATMENT--Salt
Removal/WATER SUPPLY--Saudi Arabia/CONCRETE REINFORCEMENTS/
CORROSION/RED SEA

17. **Asir water desalination project nearing completion.**
Al Riyadh, p. 4, Jan. 31, 1988.

STATISTICAL YEARS: 1988 The SR 2.4 bil Asir water desalination project, which is nearing completion along the Red Sea, will supply 24 mil gallons of water daily and generate 128 mw of electricity, according to report issued in Riyadh Fri, Jan 29. Located in Al Shaqeeq town of the Asir region, the project comprises 4 desalination units which have been established at a cost of over SR 800 mil, pipelines, pumping stations and large water tanks. The electricity power generated at the plant will be used for the desalination units, the housing complex at Al Shaqeeq and pumping station while the surplus will be passed on to the Saudi Consolidated Electricity Company in the Southern Province. "About 91% of the project's 1st phase has been completed," the report said. Saline Water Conversion Corp's Governor Abdulla Ghaleeqa had earlier said the project would be operational by the middle of this year. The 2nd phase of the project, which is to cost more than SR 1.5 bil, includes construction of a 102-km iron pipeline with a diameter of 42 inches from Al Shaqeeq to Abha and another 35.5 km pipeline with a diameter of 36 inches to the water tanks at Aqqad. There is a 39-km pipeline with a diameter of 20 inches supplying water to the Ibn Numan tanks at the military city. According to the report, the plant will have 3 main and 1 reserve pumping stations with control centres and 5 reinforced concrete tanks in Abha (with a capacity of 50,000 cu m), Al Binaman (50,000 cu m), Aqqad (20,000 cu m) and Uhd Rufeida (8,000 cu m). The Abha tank will supply water to Abha and Sawda areas, Al Binaman tank to Al Khamees city, Aqqad tank to Al Darb and Jizan regions and Uhd Rufeida to Uhd Rufeida city and its suburbs, the report said. The project also includes construction of reinforced concrete pipelines, a number of bridges and tunnels. Several well qualified engineers including 12 Saudis are supervising the plant's construction
Index terms: Saudi Arabia/Industry--Water Industry/Energy--
Electric Power-- Pipelines/Profiles/Statistics

18. Barba, D.; D. Bogazzi; A. Germana', ... et al. (Euteco S.p.A., Viale dell'Umanesimo 32, Rome, Italy)

Design and operation of 2X2.5 migd Bahrain desalination plants. DESALINATION, vol. 26, no. 2 Aug. 1978.

A description is given of the design and commissioning activities that have led to the commercial operation of Sitra Power and Water Station Desalting Plant, a plant with a rated capacity of 22,700 m3 of fresh water/d (2X2.5 migd). The main operations of the plants are included with a report on the first 16 months of commercial operation. MS
Index terms: Desalination plants/Design/Water treatment/Water sources/Persian Gulf/Saudi Arabia Coast /Sitra Power and Water Station Desalting Plant/Bahrain

19. Bechtel National, Inc., San Francisco, CA.
Conceptual Design and Cost Study for a Dual-Purpose Nuclear-Electric Reverse Osmosis Seawater Conversion Plant.
Washington, D.C. : U.S. Department of Energy., Apr 79. 130 p.
Report #: ORNL/TM-6821

The objective of this study was to develop a conceptual design and cost estimate for a 25 million gallon per day seawater reverse osmosis desalting plant operating at both Caribbean and Persian Gulf sites. The plant would operate in conjunction with a 1000 MW(e) nuclear power plant. Four seawater membrane manufacturers were supplied with feedwater analysis and a simplified cost estimating procedure in order to recommend membrane systems which would be applicable. For both sites a two-stage system was selected for development of a conceptual cost estimate. The product water cost was found to be (based upon 1978 United States construction costs) $3.17/1000 gallons for the Caribbean site and $3.75/1000 gallons for the Persian Gulf site. (ERA citation 04:038717)
Index terms: Desalination reactors/Dual-purpose power plants/ Cost/Desalination plants/Efficiency/Feasibility studies/Nuclear power plants/Specifications /Design criteria/Membranes/Reverse osmosis desalination/Caribbean Gulf/Persian Gulf

20. Boehmer, H., and F.J. Glaze (GEA Energiesystemtechnik GmbH and Co., P.O. Box 2860, 4690 Herne 2, FRG)
Better M.S.F. plant performance by avoiding tube fouling and debris.
Proceedings of the 2. World Congress on Desalination and Water Re-use. 1985, pp. 429-439

Despite the use of chemical scale inhibitors, fouled layers still form on the tubes in the brine heater and heat recovery sections of M.S.F plants, necessitating the use of mechanical cleaning. Operating experience with GEA-EST On-line Tube Cleaning Systems in the Gulf Region is presented. The reasons for developing the batch system are outlined. The main features of the system described are reliability, low maintenance and ease of operation. Good ball distribution and avoidance of ball damage are essential requirements, and are fulfilled by this design. The benefits to be gained by the installation of a GEA-EST ball cleaning system in the heat rejection section include not only improved heat transfer but also better corrosion resistance. The need for some form of secondary screening close to the heat rejection section or make-up in-let is emphasized.
Index terms: desalination plants/corrosion control/scaling /ISW, Persian Gulf/ISW, Dubai /tube cleaning systems

21. Boesch, W.W. (Water Services of America, Milwaukee, WI.)
World's first solar powered reverse osmosis desalination plant.
Desalination, vol. 41, no. 2 p. 233-237, 1982.

The world's first solar-powered seawater reverse osmosis plant which is operating in Jeddah, Saudi Arabia, on the eastern shore of the Red Sea, is described. The system provides for the drinking water needs of a community of 250 people and also provides power for a complete digital logging system. The RO system has two membrane stages. The 42,800 ppm salinity water enters two parallel-conntected Dupont B-10 permeators after acidification and filtration. Product water is then repressurized and pumped to two B-9 permeators, reject-staged. Overall recovery is 22% with a product flow of 1.2 gallons per minute. A digital computer records 48 variables every six minutes. The data are being used to verify computer models. The plant power source is an 8 kW (peak) array of ribbon photovoltaic modules. Overall array efficiency is 7.5%.
Index terms: desalination/desalination plants/reverse osmosis/ drinking water/electric power/Saudi Arabia/digital computers/ logging (recording)/mathematical models/Jeddah/Red Sea.

22. Brining, D.L.; W.C. Lester; W.N. Jessee; D.A. O'Leary; S. Bourgeois, and M.S. A. Salam. (Lockheed Ocean Sci. Lab.; Lockheed Missiles and Space Co.; Carlsbad; CA.)
Development of environmental standards for combined desalination/power generating stations in the Arabian Gulf

region.
Bakish, Robert (editor)
Water, Essence Life, Proc. Int. Congr. Desalin. Water Re-use,.
Teaneck, N. J : Int. Desalin. Environ. Assoc., 1981, p. 255-60.
Index terms: Environmental pollution (from seawater desalination-power generation, in Persian Gulf region)

23. Canetta, V., and N.M. Valota (Quality Label Assoc. for Copper Alloy Tubes for Desalination, Zurich)
MSF (multi stage flash) desalination plants: Copper alloy tubes, their economic aspects for overall cost reduction.
Proceedings of the 2. World Congress on Desalination and Water Re-use. 1985, p. 307-317

Desalination plants have greatly contributed, and are likely to do so for the 15 yr, to the economical and welfare growth in such arid areas as the Arabian Gulf, the Red Sea and North African coasts. Desalination plants for sea water are a fundamental aspect of infrastructure to sustain the growing industrialization and population in these countries, where rainfall is poor and rivers not available, where -- as in Tripoli and Bahrain -- The water acquifer decreases yearly or where huge industrial towns like Jubail and Yanbu are erected in a previously desert landscape. Budget constraints, however, require careful consideration and analysis of overall plant costs, and cost reductions nowadays are only likely to come from technical rather than commercial considerations, in view of recent dramatic plant price decreases. Being involved for 20 yr in desalination as suppliers of heat exchange tubes, and of ancillary non ferrous metal semis like tubeplates and sheets, the authors elaborate on this subject, specifically on copper alloy tubes in MSF desalination, as a significant item of possible cost reductions.
Index terms: desalination plants/water supply/arid environments/ economic analysis /sea water/copper/alloys/materials technology /multi-stage flash/copper alloy tubes

24. Darwish, M.A.; M. Abdel-Jawad, and L.J. Hauge (Kuwait Inst. for Scientific Research, Safat, Kuwait)
New dual-function device for optimal energy recovery and pumping for all capacities of RO systems.
Desalination, vol. 75, no. 1-3 p. 25-39, 1989.

The cost of energy consumption represents more than 50% of the

total desalting water cost by reverse osmosis (RO) for conditions prevailing in Kuwait. Real prospects of decreasing this energy consumption exist by recovering the energy of the high pressure rejected brine. This rejected brine flowrate is about 70% of the feed flowrate and at pressure slightly below the feed pressure. In a single stage seawater RO desalting system, experience in Doha RO experimental station indicated that the energy consumed by the feed pump can be decreased by 27% when a recovered centrifugal pump type turbine is used as an energy recovery device. A similar savings of 38% is expected when a Pelton wheel type turbine will be installed shortly in Doha RO station. Towards the maximum development in reducing energy consumption, a new rotor type pressure exchanger is now under development as an energy recovery and pumping device for RO seawater desalting system at Kuwait Institute for Scientific Research. Preliminary experiments proved the success of the device in recovering most of the energy from the rejected brine and decreasing the pumping energy of the feed to the membrane modules by 60%. This percentage represents the maximum saving of energy that can be sought in the RO seawater desalting technology. Through this development, the cost of desalting seawater can approach the cost of desalting brackish water, a significant advancement in desalting seawater by RO technology. The technical characteristics of the pressure exchanger and its performance as an energy recovery device for RO system under real operating conditions in the Persian Gulf area is presented along with a flow sheet that links the new device with the feed pump, rejected brine connections and booster pump.
Index terms: desalination/reverse osmosis/Kuwait/energy consumption/seawater/economic aspects

25. De Moel, P.J.; R.F. M. De Gier, and G. Onderdelinden (DHV Consulting Engineers, Amersfoort, Netherlands)
Design of the 50,000 m3/day treatment plants for Qasim, Saudi Arabia. Desalination of brackish water at 99% recovery.
Desalination, vol. 55, p. 343-356, Nov. 1985.

The design of three 50,000 m3/day treatment plants for the water supply of the Qasim Region, Saudi Arabia is discussed. Constraints on brine discharge in this inland agricultural development region have resulted in the design of desalination plants operating at 99% overall recovery. The plants include pellet softening, rapid sand filtration, reverse-osmosis (RO) desalination, and brine recovery. The pellet softening enables

the operation of the RO section at 90% recovery. The brine of the RO is distilled by vapour compression, recovering 90% of the brine flow while the concentrated brine is evaporated in lined ponds.
Index terms: desalination/reverse osmosis/plant design/water purification

26. **DESALINATION PLANT SLOWED BY TOXIC SPILL.**
United Press International, Feb 8, 1991.

27. **Desalters sow seeds for Saudi industry.**
Chemical Week, vol. 117, no. 7 p. 57-58, Aug. 13, 1975.

Three dual-purpose desalination and electric generating plants have been planned for Saudi Arabia. A 50 mgd, 500-mw plant in Jeddah on the Red Sea is being designed by a British firm, while two plants in the Eastern Province, a 30 mgd, 300-mw plant at Al-Jobail and a 5 mgd, 50-mw plant at Al-Khafji, are being designed by a United States corporation. A conventional desalination method of multi-stage flash evaporation will be employed. While this technique requires a large amount of steam to make fresh water, the hydrocarbons necessary for producing steam are plentiful in Saudi Arabia and the need for water is crucial. By integrating the desalting plants with the production of electrical power, the fresh water production costs will be only 12 cents per cu m. The actual engineering, designing, and construction of the three plants will cost $15 billion and contracts will be divided into packages for bidding. Among these packages are: a power plant, including the steam boiler, site preparation, intake and outfall for the plant; living quarters for workers building the plant; and outside facilities such as power transmission. Additionally, Saudi Arabia has provided $3.5 million to organize a research center to study seawater desalination and related problems such as corrosion.
Index terms: desalination/treatment facilities/design/ powerplants/sea water/electrical engineering/waste water treatment/water treatment/Saudi Arabia.

28. Edalat, M.; J. Entessari, and H. Hamidi (Atomic Energy Organization of Iran, Nuclear Power Plant Management, Tehran, Iran)
The Bushehr 200,000 m3/d desalination plant.
DESALINATION, vol. 26, no. 2 Aug. 1978.

The need for water in the Bushehr province and the construction of 2 very large nuclear power plants in that area made the construction and operation of two 100,000 m3/d desalination units feasible. The nuclear power plant can provide a reliable supply of steam to operate the desalination plant. Because a hot water closed loop is provided as a safety barrier, no impairment of the operation of the desalination plant arises as a result of the danger of radioactive contamination. The importance and necessity of a very clear specification for ordering such a large plant was appreciated. Therefore, a bid specification in which a clear definition of what documents were required from the supplier was prepared. From this, the Atomic Energy Organization of Iran could make a real comparison of what was offered by the different suppliers and received all the possible benefits they could from competition. Construction and operation of the 2 large desalination units will fulfill the national needs for water production and transfer of technology in this field. FT
Index terms: Desalination plants/Water treatment/Design/ Economics/Costs/Water sources/Persian Gulf/Iran Coast /Bushehr plant

29. El Difrawi, Ahmed, and Bernard Yudow (GDC Int Inc, Chicago, IL, USA Int Solar Energy Soc, American Section)
INTEGRATED SOLAR DESALINATION/AGRICULTURE PILOT PLANT IN EGYPT DESIGN AND CONSTRUCTION UPDATE.
Progress in Solar Energy, Volume 6, p. 603-606, 1983.
Publ by American Solar Energy Soc, New York, NY and Boulder, CO, USA

A program to build a solar desalination pilot plant coupled with a Controlled Environment Agriculture (CEA) system in Egypt, is underway. The desalination cycle is based on three stages: two humidification processes and one dehumidification process. Updated work progress on the preliminary process flow diagrams - daytime and nighttime operations and the sensitivity analysis relative to given parameters for a base case - is to be presented. The base case constitutes a set of parameters representing the average conditions expected at the project site on the Red Sea at the city of Hurghada.
Index terms: SOLAR ENERGY--Applications/AGRICULTURE--Energy Utilization/ MATHEMATICAL TECHNIQUES--Sensitivity Analysis /SOLAR DESALINATION PILOT PLANT/CONTROLLED ENVIRONMENT AGRICULTURE (CEA)

30. El Din, A.M.S., and R.A. Mohammed (Mater. Test. Lab., Water and Electr. Dep., P.O. Box 219, Abu Dhabi, UAE.)
The problem of alkaline scale formation from a study on Arabian Gulf water.
DESALINATION, vol. 71, no. 3, p. 313-324, 1989.

An experimental procedure is developed to study alkaline scale formation from Arabian Gulf water. The brine is refluxed at increasing temperatures under N sub(2) bubbling for five hours. After cooling to room temperature the water is analyzed for HCO sub(3)@)u-, CO sub(3)@) super(2)-a)nd OH super(-) in solution and for precipitated CaCO sub(3) and Mg(OH) sub(2). The results indicate the presence of appreciable quantities of soluble CO sub(3)@) super(2)-e)xceeding the limits of the solubility product of CaCO sub(3), and reveal the inadequacy of thermodynamic approach for studying scale formation. Solid CaCO sub(3) formation in measurable quantities starts above ca. 65 degree C, reaches a maximum at 80 degree C and declines to a constant value at 90 degree C. Mg(OH) sub(2) precipitation starts around 75 degree C and increases steadily with rise in temperature.
Index terms: desalination/sea water/scaling/calcium carbonates/ chemical reactions/thermodynamic equilibrium /ISW, Persian Gulf

31. El-Nasher, Ali. M; Qamhiyeh, Amer A.
Performance simulation of the heat accumulator of the Abu Dhabi solar desalination plant.
Solar Energy, v. 44, no. 4 p. 183-91, 1990.

32. **Expenditure on domestic development projects, 1970-1982.**
Khaleej Times, p. 17, Oct. 4, 1983.
Saudi Arabia spent $ 197 bil on domestic development projects between 1970 and 1982, authorities said Monday, Oct 3. According to a report of the Ministry for Economical Development, the energy production capacity was raised from 418 mw to 11,774 mw during the period. The capacity of desalination plants rose from about 20 to 680 mil litres a day. A total of 36.4 mil ton of goods were unloaded in 1982 in the Red Sea and Gulf ports compared to 1.8 mil ton in 1970, the kingdom launched first 5-yr plan
Index terms: Saudi Arabia/Economics--Government Expenditures/ Industry--Water Industry.

33. Fohner, C.N. (Stearns Catalytic World Corp., Denver,

Colorado)
Desalination plant is basis for 1300 MW of cogenerated power.
Power Engineering, vol. 89, no. 8 p. 38-41, Aug. 1985.

A dual-purpose desalination-power plant provides up to 210 million gallons per day of fresh water and 1300 megawatts of electric power. The plant, which is located on the Persian Gulf, was built between 1978 and 1984 by Saudi, Japanese, French and Italian contractors. The multistage flash evaporator units use polyphosphate as a scale control additive. In order to achieve the specified 210 million gpd water production, 40 evaporator units, each rated at 6.24 million gpd, were required, with a planned availibility of 34 units (85%) on line. The plant has 20 seawater intake pumps, each 110,000 gpm capacity, housed in four intake structures. The product water is passivated with lime and disinfected with chlorine at a product water treatment complex.
Index terms: cogenerated power/desalination/desalination plants/ electric powerplants/Saudi Arabia/dual-purpose plants.

34. **Four solar-powered desalination projects in Egypt.**
Al Ahram, p. 8, Nov. 4, 1987.

The erection of 4 solar-operated desalination projects producing 150,000 cu m of water a day is under way in Matrouh governorate, Al Ghardaqa at the Red Sea and Dahab village.
Index terms: Egypt/Energy--Solar Energy/Industry--Water Industry

35. Glueckstern, P.; Y. Kantor, and M. Wilf (Mekorot Water Co.; Tel Aviv; Israel)
Field trials and preliminary evaluation of reverse osmosis systems for seawater desalting at the Red Sea shore.
Proc. Int. Symp. Fresh Water Sea, vol. 6, no. 3, p. 307-16, 1978.
Index terms: desalination seawater reverse osmosis /Water purification,desalination (reverse osmosis in, of Red Sea water)

36. Glueckstern, P.; M. Wilf, and Y. Kantor (Mekorot Water Co, Tel Aviv, Isr)
FIELD TESTING AND ECONOMIC EVALUATION OF RO SEAWATER TECHNOLOGY.
Proc of the Int Congr on Desalin and Water Re-use, K. C. Channabasappa Mem, Water for Life, Nice, Fr, Oct 21-27 1979, 1979.
Sponsored by Int Desalin and Environ Assoc (IDEA), Teaneck, NJ,

1979. v 1 (also publ as Desalination v 30, 1979) p 235-245.

An experimental reverse osmosis (RO) seawater system has been in operation for two years at Eilat on the Red-Sea shore. Simplified seawater pretreatment, comprising only sand filtration and acid dosing was applied. Hollow fiber and spiral wound membranes were tested. Evaluation of pretreatment effectiveness and comparative membrane performances are reported. Investment and water cost analysis of a 4,000 m**3/day RO seawater desalting system under various operating conditions is given. The analysis is based on the results of experimental site operation, current technology development and updated industrial quotations. The resulting water production cost from a one-stage system is approximately $1.1/m**3. 11 refs.
Index terms: SEAWATER--Salt Removal/OSMOSIS, REVERSE/WATER SUPPLY/DESALINATION--Economics

37. Hamdan, L. (Earth Sci. Dep., Kuwait Inst. Sci. Res., P.O. Box 24885, 13109 Safat, Kuwait)
Water resources research needs in the Arabian Gulf area.
DESALINATION, VOL. 72, NO. 1-2, 1989.
Proceedings of the Kuwait Symp. on Management and Technology of Water Resources in Arid Zones, Kuwait, October 5-7, 1987.

Priority goals of water resources research in the arid Gulf Cooperation Council Countries are outlined, and rationalized, and studies to accomplish these goals are suggested. The research goals include preservation and protection of aquifers; improving water distribution and use efficiency; reducing the coast of water production; securing supply sources to meet future water demands; and development of centralized national data banks and trained national cadres in water resources science and technology.
Index terms: water resources/desalination/water supply/water treatment/data collections/Kuwait/Saudi Arabia/Oman/Qatar/ Bahrain/United Arab Emirates/ISW, Persian Gulf /Gulf Coop. Counc

38. Hammer, M.J.
Water supply in Saudi Arabia. Part 1: desalinated seawater.
Middle East Water & Sewage, vol. 11, no. 2, p. 50-51, May 1987.

Describes the principles of desalination of sea water with emphasis on the design of plants in Saudi Arabia. The sea waters of the Red Sea and the Arabian Gulf are reduced from

salinities in the range of 40,000 to 60,000 mg/litre to less than 100 mg/litre by multi stage flash distillation plants. The water is further stabilized, to prevent internal corrosion, and then fluoridated. Indicates costs of desalination. (C.J.U.)

39. Hassan, A.M.; S. Al-Jarrah; T. Al-Lohibi, and A. Al-Hamdan (Saline Water Conversion Corp., Research Development Training Center, Al-Jubail, Saudi Arabia)
Performance evaluation of SWCC SWRO plants.
Desalination, vol. 74, no. 1-3, p. 37-50, Nov. 1989.

The study deals with the performance evaluation of three SWCC seawater reverse osmosis plants: the 4400 m3d Umm Lujj Plant commissioned July 1986; the 2275 m3d Al-Birk Plant commissioned Dec. 1983; and the 1200 m3d Jeddah plant commissioned 1979. The three plants show only a modest annual decline (from design) in productivity ranging from 2.5% at Jeddah to 3.5% at Umm Lujj, and 7.17% at Al-Birk. The larger decline at Al-Birk plant is due to biological fouling of membranes. Product water quality at Umm Lujj and Al-Birk with TDS less than 250 ppm, is within WHO recommended standard of 500 ppm. Salt rejection by both stages of 99.5% at both Umm Lujj and Al-Birk plants indicates that their membranes did not suffer any serious structural damage. The decline in salt rejection at both plants is less than 0.2% per year. There has been a decline in salt rejection in the Jeddah plant, indicating structural damage to the membrane. Umm Lujj and Jeddah plants had over 95% plant availibility, but their water recovery was 24-28%. Biological fouling was a problem with the Al-Birk plant in which the feed was chlorinated (4 ppm) and dechlorinated while no biological fouling was reported for the other two plants in which the feed was disinfected by (0.5-1 ppm) copper sulphate. Other problems encountered were material corrosion especially with SS 316 and SS 316L in both pretreatment and desalination parts of the Jeddah plant.
Index terms: plant operation/reverse osmosis/desalination

40. Hassan, A.M., and A.U. Malik (Saline Water Conversion Corp., Research Development Training Center, Al-Jubail, Saudi Arabia)
Corrosion resistant materials for seawater RO plants.
Desalination, vol. 74, no. 1-3, p. 157-170, Nov. 1989.

A survey of corrosion resistant materials employed in Seawater Reverse Osmosis (SWRO) desalination plants in Saudi Arabia and the GCC countries was carried out with special reference to

stainless steels. The history of the application of these materials encountered in those plants with main emphasis on SWCC RO desalination plants. The two SS alloys 315L and 317L were used in two plants with no noticable corrosion damage for over 5 years and 3 years. Similarly, other SS alloys 317LN, 904L, 245MO and 329 performed well, without any significant corrosion. The role is discussed of different alloying additions in determining the corrosion resistance and mechanical properties of stainless steels relevant to SWRO desalination applications. The feasibility of using deaerated seawater feed in RO plants is discussed.
Index terms: corrosion resistance/desalination/construction material

41. Heitmann, H.G.; Ch Gabriel, and K. Gabelgaard (Kraftwerk Union, Erlangen, Germany)
Desalination of Seawater for Uses as Pot Water and Industrial Water for Nuclear Plant Applications = TRINK- UND BRAUCHWASSERVERSORGUNG VON KERNKRAFTWERKEN AUS MEERWASSER.
Int Symp on Fresh Water from the Sea, 6th 205th Event of the Eur Fed of Chem Eng, Las Palmas, Grand Canary, Spain, Sep 17-22 1978, vol. 1, no. 379-388, 1978.
Publ by Eur Fed of Chem Eng, Frankfurt AM, Germany

This report describes seawater desalination plant which has been installed in Bushehr on the Persian Gulf to produce pot water and process water for use in two nuclear plants now under construction in the area. Two *desalination* units, each with a net output of 500 m**3/d, operate on the multi-stage flash distillation principle. A third unit with a net output of 2400 m**3/d is made up of a combination of multi-stage evaporation and flash distillation (multi-flash) equipment. The distillation units with 500 m**3/d net output each consist of 18 pre-heater and evaporator stages. The 2400 m**3/d net output distillation unit incorporates a heat removal section from which about 2/3 of the water fed in is returned to the sea. The distillation unit proper consists of 10 evaporators arranged in series in which the water picks up the condensation heat from the evaporating brine in each stage as it passes from stage to stage. The steam generated in each stage is extracted via droplet separators and condensed on the preheaters. The distillate to be used for drinking water supplies is enriched with air, has CO//2 added and is then hardened in a Magno filter. It is then sterilized by

adding NaOCl and filtered through activated carbon filters.
In German.
Index terms: WATER TREATMENT PLANTS--Design/SEAWATER--Distillation/DESALINATION/NUCLEAR POWER PLANTS/WATER TREATMENT,

42. Hickman, Carl E.; Issam Jamjoom; Alan B. Riedinger, and Ralph E. Seaton (UOP Inc, San Diego, California)
JEDDAH SEAWATER REVERSE OSMOSIS INSTALLATION.
Tech Proc Annu Conf Natl Water Supply Improv Assoc 7th, New Orleans, La, Sept. 16-20 1979, Sess 2, 24 p., 1979.
Publ by Natl Water Supply Improv Assoc, Ipswich, Mass.

The large reverse osmosis system for seawater desalination described was placed on-line in January 1979 to supply 12,000 cubic meters of desalted Red Sea water per day to the drinking water supplies of Jeddah, Saudi Arabia. This system is based on the newly developed spiral-wound TFC membrane elements. The system consists of power generation, a seawater intake, dual media filtration, nine first-stage reverse osmosis units, three second-stage reverse osmosis units and product stabilization. Experience to date with the design, construction and installation of this large reverse osmosis system for the desalination of seawater is discussed.
Index terms: SEAWATER--Salt Removal/OSMOSIS, REVERSE/DESALINATION/MEMBRANES

43. Hussein, Fahmy M.
Selection of a suitable reactor type for water desalination and power generation in Saudi Arabia.
Nuclear Technology, v. 80, p. 392-9, March 1988.

44. Hussein, Fahmy M.; Mohamed A. Obeid, and Khalid S. El-Malahy (King Saud Univ, Riyadh, Saudi Arabia)
SITE SELECTION OF A DUAL PURPOSE NUCLEAR POWER PLANT IN SAUDI ARABIA.
Nuclear Technology, vol. 79, no. 3, p. 311-321, Dec 1987.

Selecting a nuclear power plant site for power production and water desalination is a very complex problem, especially in countries with moderate technology. Many interrelated factors affect the process, and professional judgments by various experts are involved. Four sites, all located on the West Coast of Saudi Arabia along the Red Sea, were chosen as potential

sites for building such a plant. (All sites were in either the northern or southern section of the coast; the central part was excluded for pilgrims' safety.) The East Coast was completely eliminated in the initial screening process due to its strategic location, the existence of oil fields and refineries, and its proximity to other Arabian (Persian) Gulf countries (to minimize radioactive releases to these countries in case of an accident). A computer code based on Saaty's eigenvalue technique and developed in a previous study was used in this analysis. Twenty-one main criteria were considered, and the sites were ranked to determine which was most desirable. Site 4 was found to be most suitable, followed by site 3. (Author abstract) 26 refs.
Index terms: NUCLEAR POWER PLANTS--Site Selection/DESALINATION--Saudi Arabia/ MATHEMATICAL TECHNIQUES--Eigenvalues and Eigenfunctions /SAATY'S EIGENVALUE TECHNIQUE/COST-BENEFIT ANALYSIS

45. Isikoff, Michael.
Saudis brace for onslaught of oil slick; water desalination plants on coast are threatened. (Persian Gulf War)
Washington Post, v 114 col 1 p. A22, Jan 27, 1991.
Index terms: Persian Gulf War, 1991--Environmental Aspects; Oil spills--Persian Gulf; Kuwait--Military activity

46. Khummayis, D.S. (Saline Water Conversion Corp., Eastern Province, Al-Khobar, Saudi Arabia)
Saudi Arabia: twenty years of desalination.
Non-Conventional Water Resources Use in Developing Countries. Proceedings of the Interregional Seminar. 1985, p. 433-435.

Saudi Arabia depends heavily upon desalination of brackish and sea water for freshwater supplies. In 1974 the Saline Water Conversion Corporation (SWCC) was founded by Royal Decree to build, operate, and maintain desalination plants to provide an adequate and reliable water source. At first two small single purpose multistage flash distillation plants were built on the Red Sea. In 1980, a dual purpose facility with a multi-stage flash desalter connected to a power generation plant was built. By 1985, 15 plants on the Red Sea and 4 on the Gulf were in operation. SWCC expanded to include service not only to coastal locations, but also to inland sites. SWCC qualified Saudi engineers are now taking a more important and involved role in

the operation and maintenance of the plants. The number of Saudis working in desalination plants is continually rising due to the availibility of graduates from the two SWCC training centers. To lessen problems of corrosion and poor design parameters the following were suggested: more attention should be given to material selection; external deaerators should be used to limit dissolved oxygen levels; chemical additives should be used for scale treatment; ball cleaning must be used to increase the running period before acid cleaning when on-line additives are used; and during both the design and the plant operation stages, strict control on allowable minimum brine recycle pressure is needed to restrict boiling of the recycle feed in the brine heater tubes.
Index terms: desalination/Saudi Arabia/water supply development/ multistage flash distillation/distillation/developing countries/ maintenance/drinking water/project planning/labor/training/ corrosion/process control/brines

47. Kurihara, M.; Y. Nakagawa; H. Takeuchi; N. Kanamaru, and T. Tonamura (Toray Industries, Inc., Shiga, Japan)
Single-stage seawater desalination at high temperature and salinity as present in the Middle East using PEC-1000 membrane modules.
Desalination, vol. 46, p. 101-110, May 1983.

In the Middle East, where desalination is needed most urgently, both salinity and temperature of the seawater are very high, presenting problems for reverse osmosis (RO) desalination. Performance and long-term durability tests were carried out at a demonstration test facility using single-stage seawater reverse osmosis (SWRO) at high salinity and temperature, using PEC-1000 membrane modules. Since the seawater salinity at the test facility is 3.5% TDS, and the seawater salinity in the Middle East (Red Sea and Arabian Gulf) is about 4 to 5%, a part of the brine rejected from the RO modules is recycled to control the feed water salinity for the tests. Based on the long-term field test results, PEC-1000 membrane elements exhibit sufficiently enough performance and durability for the complete single-stage seawater RO in the Middle East and the permeate salinity is low enough for the WHO standard (500 ppm TDS) even at high water recovery rate such as 35-40%.
Index terms: desalination/reverse osmosis/seawater/salinity/water temperature/Red Sea/Arabian Gulf

48. Light, W.G.; J.L. Perlman; A.B. Riedinger, and D.F. Needham (Allied-Signal Inc, San Diego, CA, USA Commonwealth Special Research Cent, Australia)
Desalination of non-chlorinated surface seawater using TFC membrane elements.
Desalination, vol. 70, no. 1-3, p 47-64, Nov 1988.
IMTEC '88 - International Membrane Technology Conference '88.

The Umm Lujj II reverse osmosis (RO) desalination plant in Saudi Arabia has produced high quality potable water left bracket less than 200 mg/L total dissolved solids (TDS) concentration right bracket at better than design capacity left bracket 4400 m**3/d (1.16 MGD) right bracket from non-chlorinated Red Sea surface seawater (42 g/L TDS concentration) since May 1986. The plant employs thin-film composite (TFC**R) spiral-wound membrane elements manufactured by UOP Fluid Systems. During the two years of operation, there have been no element additions or replacements and no element cleaning has been required. It is proposed that the long-term stability of TFC**R membrane with non-chlorinated surface seawater is due to its surface properties. (Edited author abstract) 9 Refs.
Index terms: DESALINATION/OSMOSIS, REVERSE--Equipment/SEAWATER--Salt Removal/ MEMBRANES--Components/COPPER COMPOUNDS--Concentration /POTABLE WATER/SPIRAL-WOUND MEMBRANE ELEMENTS/ HEXAMETAPHOSPHATE

49. Lippmann, G., and K. Schubert
Solar desalination by multi-stage flash vapourization.
DORNIER POST, No. 2 1979.

The use of solar energy for seawater desalination is one of the earliest technical applications of solar energy. The Dornier System has designed a solar desalination plant (SDP) which functions independently of external energy supplies. This system uses heat pipes to separate the solar collector and the distiller which increases the effectiveness of the 2 plant subsystems. A SDP opened in Aug. 1977 in Aquba on the Red Sea with a total surface of 400 m2 and productivity of 1.5-2 m3/d. The plant has 2 subsystems; the desalination unit which operates to the multi-stage flash vaporization principle, and the solar-energy unit which collects and transfers solar heat. Details of the 2 subsystems and the heat-effectiveness of solar energy are provided. FT

Index terms: Desalination methods/Vaporization/Solar energy/ Seawater/ Desalination plants/Red Sea /solar desalination/Dornier System/Aquba/multi-stage flash vaporization

50. Logan, Douglas P., and Susan Crnkovich (Calgon Corp.; Pittsburgh; Pennsylvania)
Calcium sulfate threshold and adherence studies in heated synthetic (Persian) Gulf brines.
Arabian J. Sci. Eng., vol. 8, no. 3, p. 179-93, 1983.
Index terms: calcium sulfate seawater desalination brine /Water purification,scale control (in heated brines in multistage-flash evapn. desalination of seawater) /Water purification,desalination (multistage-flash evapn. in, of seawater, calcium sulfate formation in heated brines in) /Water purifn., evapn., multistage flash (seawater desalination by, calcium sulfate formation in heated brines in)

51. Malik, A.L.A.; K.M. Mousa; N.G. Younan, and B.J.R. Rao (Water Resources Development Centre, M.E.W., Shamiya, Kuwait)
Performance evaluation of three different seawater RO membranes at DROP in Kuwait.
Desalination, vol. 63, p. 163-192, June 1987.

Kuwait has realized that in spite of the success achieved in desalination of normal seawater by reverse osmosis (RO), additional problems are presented by Arabian Gulf seawater, which has higher total dissolved solids, silt density, and temperature. Hence, a joint program between the Water Resources Development Centre of Kuwait, the Kuwait Institute for Scientific Research, and GKSS of the Federal Republic of Germany has been established in Kuwait to carry out the operation of three independent reverse osmosis lines each of 1000 cubic meters per day capacity; these lines, at the Doha Reverse Osmosis Plant (DROP), are operated in parallel. The seawater membranes used in the first stage of the three lines are: spiral-wound UOP - 1501, hollow fine-fiber Dupont B-10, and plate and frame membranes of Enro, Schleicher and Schull (RO 112), and Filmtec (FT-30). The membranes used in second stage are spiral-wound UOP-8600, hollow fine-fiber Dupont B-9, and spiral-wound Hydronautics 8040B, respectively. The average overall recovery ratios for lines 1 to 3 were 24,8,24,1 and 29.6% compared with design values of 27,25, and 32%. First stage salt rejection for lines 1 and 2 was about 85 and 98.4%; rejection values for the second stage of these lines were about 90 and 95%. In line 3, the Filmtec membranes were found to have a

constant permate conductivity while permeate conductivity of the Enro and Schleicher & Schull membranes increased, affecting overall performance; performance was improved by replacing some Enro membranes by Filmtec membranes. The average values of power consumption for lines 1 and 3 (with energy recovery) were about 10.6 and 18 KWH per cubic meter; power consumption (without energy recovery) for line 2 was about 13.5 KWH per cubic meter. The average availibility of lines 1 to 3 was 92.8, 89.5, and 85.2% respectivily.
Index terms: water treatment/water treatment facilities/ desalination/desalination apparatus/desalination plants/membrane processes/reverse osmosis/Kuwait/comparison studies/salt rejection/Doha Reverse Osmosis Plant/conductivity/Persian Gulf

52. Marotz, G.
Jeddah IV Seawater Desalination and Power Plant in operation in Saudi Arabia = Meerwasserentsalzungs und Kraftanlage Jeddah IV in Saudi Arabien in Betrieb.
Wasserwirtschaft, vol. 71, no. 12, p. 377-378, 1981.

The Jeddah IV seawater desalination and power plant was put into operation in Saudi Arabia on October 24, 1981. This is currently the largest such plant in the world, and upon full operation will supply about 220,000 cu m of drinking water per day. It is located on the Red Sea, about 8 km north of the city of Jeddah. It covers an area of 20 hectares and supplies electrical energy as well as water. Five oil-fired boilers produce 605 t/hr of steam which is used to run the turbines and as the desalination starting product. The basic process for desalination is multi-stage flash distillation. Ten desalination sections can be operated independently, at a brine temperature of 112 C. Sulfuric acid is added to prevent the deposition of magnesium hydroxide and calcium carbonate in the evaporator-condenser chambers. The boiler supply and cooling water (43 cu m/sec at full capacity) is collected at 16 m below the sea surface, and pre-purified with rakes and band filters. Oil is delivered by tank ship, with sufficient storage capacity on site for 32 days of operation.
Index terms: desalination/distillation/powerplants/Saudi Arabia/ Red Sea/Jeddah/seawater/boilers/turbines/water supply/water treatment

53. Midwest Research Inst., Kansas City, MO.
SOLERAS - Solar Energy Water Desalination Project: Chicago Bridge and Iron Company. Final Report: System Design Extension.

Volume 2. Appendices and Drawings.
Washington, DC. : Department of Energy, 1985. 746 p.
Report #: DE86001284/XAB

The report concerns the design of a solar energy powered, seawater desalination pilot plant for installation at Yanbu, Saudi Arabia, on the shore of the Red Sea. General specifications, major equipment specifications, vendor and operation and maintenance information, as well as design drawings, are presented. (ERA citation 11:002286)
Index terms: Desalination Plants/Absorption Refrigeration Cycle/ Control Systems/ Deaerators/Desalination/Design/Engineering

54. Midwest Research Inst., Kansas City, Missouri.
SOLERAS - Solar Energy Water Desalination Project: Chicago Bridge and Iron Company. Final Report: System Design Extension. Volume 1. Technical Report.
Washington, DC. : Department of Energy, 1985. 200 p.
Report #: DE86001276/XAB

The design of a solar energy powered, sea water desalination pilot plant for installation at Yanbu, Saudi Arabia, on the shore of the Red Sea is presented. Earlier work is introduced and a description of the system is presented. Important design analyses and cost reduction considerations are reviewed. The pilot plant design is described in detail. Construction plans for and projected operation of the plant are discussed. (ERA citation 11:002285)
Index terms: Desalination Plants/Construction/Desalination/ Design/Economics/ Fresnel Reflectors/Heliostats/Maintenance/ Operation/Parabolic Dish Collectors/Seawater

55. Midwest Research Inst., Kansas City, Missouri.
SOLERAS - Solar Energy Water Desalination Project. Solar Energy Falling on Yanbu, Saudi Arabia, July 1985.
Washington, DC. : Department of Energy, 1986. 85 p.
Report #: DE86005643/XAB

Yanbu is located in the Western Province of Saudi Arabia on the Red Sea at a latitude of 24.1 degrees North and a longitude of 37.8 degrees East. It was selected as the location for the Soleras Solar Powered Desalination Plant. This preliminary report describes the direct normal and total horizontal insolation that fell on the Yanbu Solar Powered Desalination

site during the month of July 1985. (ERA citation 11:012931)
Index terms: Saudi Arabia/Direct Solar Radiation/Experimental Data/Insolation/ERDA/Yanbu (Saudi Arabia)

56. **Oil spill in Gulf hinders fishing, desalination.**
Aviation Week & Space Technology, vol. 118, p.44(2), May 23, 1983.

57. Olsson, J., and M.L. Erbing (Avesta AB, Res. and Dev., S-77401 Avesta, Sweden)
Experiences with a highly alloyed stainless steel in desalination plants and other Arabian Gulf industrial plants.
DESALINATION. Proceedings of the 4. World Congress on Desalination and Water Reuse. VOLUME 2: OPERATIONAL EXPERIENCE -- SEAWATER RO; RESEARCH AND DEVELOPMENT -- EVAPORATIVE.
1989. pp. 267-275

The experiences from installations of the highly alloyed stainless steel UNS S31254 in desalination plants, MSF and RO, and other industrial plants in the Arabian Gulf countries are reported. More than 7 yrs of successful operation has shown that this material resists corrosion in seawater handling systems such as high pressure piping in RO-plants, ejector condensers in MFS-plants, and cooling water piping in other industrial plants. The higher strength of UNS S31254 in comparison to AISI 316L enables a considerable reduction in wall thickness of high pressure piping in e g RO-plants.
Index terms: desalination plants/corrosion control/materials technology/stainless steel/alloys/tubing/ISW, Persian Gulf

58. Osman, Mohamed M., and Abdulrahman F. Al-Gadaani (Fac. Mar. Sci.; King Abdulaziz Univ.; Jeddah; Saudi Arabia)
Preliminary investigation on the hydrography of coastal waters in the vicinity of Jeddah power-desalination plant.
J. Fac. Mar. Sci. (King Abdulaziz Univ.), vol. 4, p. 1-13, 1985.
Index terms: hydrog coastal water desalination plant/desalination Saudi Arabia /Water purification, desalination (effluents from, coastal water hydrog. in relation to, at eastern coast of Red Sea, Saudi Arabia) desalination plant effect on, at eastern Saudi Arabia)

59. Parrish, Michael.
Oil spill threatens region's water supply with disaster. (Persian Gulf region) (The Gulf War)

Los Angeles Times, v 110 col 3 p. A6, Jan 26, 1991.

60. Portmann, C.
The Riyadh Water Transmission System.
In: Europipe '82, European Conf. for the Construction and Maintenance of Pipelines, (Basle, Switzerland: Jan. 18-20, 1982), Session 4, Paper 10, p. 105-108, 1982.
Publisher: St. Albans, U.K., Access Conf. Ltd.

The Riyadh Water Transmission System was described as the largest and most ambitious water transmission installations ever undertaken. There were no significant technical innovations, but largely traditional methods used under new and severe conditions. The purpose of this installation was to supply drinking water to the town of Riyadh from the output of the desalination plant at Al Jubail on the Persian Gulf, to the north of Dharan. This paper gives details of the system with particular reference to the behanviour of the internal pipeline lining of cement-based mortar. (from author's abstract)

61. Riedinger, A.B.
Performance of the 12,000 cu,m/d Seawater Reverse Osmosis Desalination Plant at Jeddah, Saudi Arabia.
American Institute of Chemical Engineers 72nd Annual Meeting. 1979. Paper no. 12f.

The design and operating experience of the world's largest seawater desalination plant which is producing drinking water from the Red Sea is described. Comparisons are made with other desalination processes.
Index terms: process design/plant design/utility/water/process operation/plant operation/process control

62. Riedinger, A.B., and C.E. Hickman (UOP Inc, San Diego, Calif.)
CONSIDERATIONS OF ENERGY CONSUMPTION IN DESALINATION BY REVERSE OSMOSIS.
Desalination, vol. 40, no. 3, p. 259-270, Mar 1982.
Round Table Conf - Influence of Thermodyn and Econ Aspects in Energy Consumption for Water Prod, Amsterdam, Neth, Sep 23-26 1980.

The primary factors affecting the energy consumption of a reverse osmosis plant are considered. These are the osmotic pressure of

the feedwater, the feedwater temperature, the water recovery, and the relationship between the water flux and salt flux characteristics of the membrane. In addition, the required permeate quality may have several indirect effects on the energy consumption. Permeate quality standards may impose minimum operating pressures, limit the recovery, and/or require treatment with a full or partial second stage. As a general rule, the energy required increases with increasing feed salinity and increasing permeate quality. Energy recovery systems can recover between 50 and 90 percent of the available energy in a reverse osmosis unit, thus significantly lowering the energy consumption. Studies have shown that with an energy recovery system, the minimum energy consumption occurs at a first stage recovery of 30 to 35 percent. Currently, very few energy recovery systems are in use due to their high capital cost, but as energy recovery systems become more available and reliable, they will greatly increase the energy efficiency of reverse osmosis plants.
Index terms: SEAWATER--Salt Removal/OSMOSIS, REVERSE--Energy Utilization/WATER TREATMENT PLANTS--Energy Utilization /ENERGY RECOVERY/RED SEA WATER/BRACKISH WATER/DESALINATION PLANTS

63. Riley, R.L., and C.E. Milstead (Universal Oil Products Company, San Diego, CA. Fluid Systems Division)
Research and Development on a Spiral-Wound Membrane System for Single-Stage Seawater Desalination Final Report.
Washington, DC. : Office of Water Research and Technology, 31 Oct 79. 298 p.
Report #: PB80-114705

Single-stage desalination of seawater by reverse osmosis requires a membrane which approaches theoretical semipermeability and is sufficiently thin to provide transport of water at practical operating pressures and recovery rates. This objective has been achieved by the development of a family of four thin-film composite membranes (TFC) based on nitrogen-containing polymers supported on a fabric-reinforced porous supporting membrane. Long-term field testing of spiral-wound TFC membrane elements was conducted at the OWRT Test Facility at Wrightsville Beach, NC to determine the stability of the elements as functions of feed temperature, water recovery, dissolved oxygen, cleaning techniques, etc. In laboratory tests, the relative stability of each membrane was determined to materials commonly encountered during membrane storage and operation, e.g., cleaning agents, formaldehyde, sodium thiosulfate. The world's largest reverse

osmosis system for seawater desalination, based on the newly developed spiral-wound TFC membrane elements, was placed on-line in 1979 to supply 12,000 cubic meters of desalted Red Sea water per day to the drinking water supplies of Jeddah, Saudi Arabia. Experience to date with the design, construction, installation, and operation of the plant has been consistent with expectations.
Index terms: Desalting/Membranes/Field tests/Potable water/ Osmosis/Design/ Cost analysis/Supports/Polyimide resins/ Vinylidene chloride resins/ Polycarbonate resins/Fabrics/ Stability/Feasibility /Desalination plants/Spiral wound membranes/Reverse osmosis desalination/Thin film composite membranes/Wrightsville Beach Desalination Plant/

64. Rosewicz, Barbara.
Upping the ante: Gulf oil spill shows Iraq's resolve to wage war on its own terms; largest-ever slick threatens area desalination plants and may hinder allies; Saudis are caught off guard. (Persian Gulf War)
Wall Street Journal, col 6 pA1(W) pA1(E), Jan 28, 1991.

65. Sabri, Z.A.; A.A. Husseiny; A. Valfells, ... et al. (Iowa State Univ., Engineering Research Inst., Dept. of Chemical Engineering and Nuclear Engneering, Ames, Indiana)
Prospects of the exploitation of advanced energy resources in water production in the Middle East.
Proceedings of the 1st Desalination Congress of the American Continent. Mar. 1977. p. 279-287.
Conference is in the journal,Desalination.
Index terms: Red Sea/Geothermal deposits/Desalination methods / Middle East/energy sources/geothermal desalination/natural depressions/heavy water

66. **Saline Water Conversion Corporation produces 480.55 mil of water a day.**
Arab News, p. 2, April 7, 1985.

The Saudi Arabian Saline Water Conversion Corp is producing more than 480.55 million gallons of water and 3,481 mw of electricity daily, according to the annual report of SWCC. The report said the number of water desalination plants in the Kingdom has reached 21, of which 15 are on the Red Sea coast and 6 on the Arab Gulf coast. The Red Sea coast plants produce between 60,000 and 58.1 mil gallons of water daily and 600 mw of power, while the Gulf plants contribute between 600,000 and 253.5

mil gallons of water plus 1,295 mw of electricity. A number of water plants, are under construction at Mecca, Taif, Aseer and Al Khafji. There are some projects under study like the 5th phase of Jeddah's plant which is producing 50 mil gallons of water daily and the 3rd phase of Al Wajh water plant producing 500, 000 gallons and the 2nd phase of Farasan plant which produces 500,000 gallons. The report added that the number of employees at the Corporation has reached 4,500. Of them 3,198 are Saudi natls. (SPA)
Index terms: Saudi Arabia/Industry--Water Industry/Energy--Electric Power

67. **Saudi Arabia tops the world in desalination water production.**
Al Riyadh, p. 1, Sept. 29, 1988.

Dr Adel Ahmad Bushnaq, Chmn of the Intl Desalination Society said Wed Sept. 28, that Saudi Arabia topped the world in the production of desalination water, with a capacity of 3.5 mil cu m per day followed by Kuwait 1.3 mil cu m. He said more than 1,200 unit with a minimum capacity of 100 cu m daily have been installed in Saudi Arabia, in addition to a huge desalination unit with a capacity of 2 mil cu m built on the Arabian Gulf and the Red Sea by the General Establishment for the Desalination of the Salty Water.
Index terms: Saudi Arabia/Kuwait/Industry--Water Industry/Statements

68. **Saudi Arabian desalination plant commissioned.**
ME Economic Survey, p. A6, June 27, 1988.

King Fahd Bin Abdul Azeez of Saudi Arabia last week inaugurated the new desalination and power plant at Shueiba on the Red Sea, some 100 km southwest of Mecca. The new plant, which has a capacity to produce 40 mil gallons/day of sweet water and 325 mw will supply 25 mil gallons/day to Mecca and 15 mil gallons/day to Taif via a pipeline network. Mecca is already receiving some 8 mil gallons/day of water from the plant, while supplies to Taif are scheduled to start within 3 months
Index terms: Saudi Arabia/Agriculture--Water Projects/Social Issues--Social Services

69. **SAUDI DESALINATION PLANT SLOWED BY SPILL.**
United Press International, Feb 9, 1991.

The world's largest offshore oilfied shut down half its sea water desalination

operation from the massive Persian Gulf oil spill. Intake valves on one of two desalination units at an Aramco refinery 40 miles south of th Kuwait border were fouled with oil and the unit was taken out of operation Thursday, February 7, 1991. Water for residential use was not affected as the desalination plant provides fresh water used in the oil refining process.
The January spill of an estimated 294 million gallons of oil is the largest such spill in history.
Index Terms: Middle East, War, Toxic Spills, Kuwait, Persian Gulf

70. **SAUDI OFFICIALS DENY TOXIC SPILL HAS FORCED CLOSING OF DESALINATION PLANT.**
United Press International, Feb 9, 1991.

Officials of the Saudi Aramco Oil Spill Coordinating Committee maintain that the Safaniya desalination plant is operating normally and has not been closed down due to the oil slick. Dr. Abdul Bin Al-Gain, the Saudi oil spill coordinator affirms that the estimated 7 million gallons of spilled oil is still in Kuwaiti waters, north of Saudi Arabia's maritime border. The slick has begun to move southernly and measure have been taken to deflect some of the slick if it encroaches land to the south. Aramco employees have given conflicting reports regarding the company's refinery. Measures are being taken to collect the oil before it reaches the shore.

71. Scharff, K. (GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Maschinenwesen)
Investigation of the Combination of MSF-Distillation, Reverse Osmosis and Extraction-Condensation Turbine Diss.1987. 110 p.
Report #: DE88752641/XAB

Investigations are made with respect to already existing dual purpose plants (power plant + thermal seawater desalination) to find an alternative to significantly increase drinking water production at the same primary energy input rate. One possibility to achieve this goal is the reverse osmosis process. Therefore tests on a seawater pilot plant in Kuwait (GKSS plate system, type G4) had been carried out to determine the specific energy input up to the maximum possible recovery with respect to scaling at a given pretreatment. The limiting recovery was determined to about 62% and the detected scaling was mainly aluminium silicates. With 24 figs., 12 tabs.. (ERA citation 13: 034215)
Index terms: Drinking Water/Capacity/Combined Cycles/Comparative Evaluations/ Deposits/Dual-Purpose Power Plants/Economic

Analysis/Energy Demand/ Evaporation/Membrane Transport/Membranes/ Modular Structures/ Osmosis/Performance/Persian Gulf/

72. Scharff, K. (GKSS -Forschungszent.; 2054; Geesthacht; Fed. Rep. Germany)
Testing RO (reverse osmosis) desalination at very high recoveries in the Arabian (Persian) Gulf (GKSS plate system)
Desalination, vol. 60, no. 2, p. 117-33, 1986.
Index terms: seawater reverse osmosis high recovery/desalination seawater high recovery /Water purification,desalination (by reverse osmosis, of seawater, with high recoveries, performance of plant for, in Kuwait) /Scale (coating) (on reverse-osmosis membranes in high-recovery seawater desalination plant, of Kuwait) /Water purification,reverse osmosis (seawater desalination by, with high recoveries, performance of plant for, in Kuwait)

73. Temperley, T.G. (Conan/Temperley and Associates, POB 3240, Jeddah, Saudi Arabia)
Material specification and the availability and life of desalination equipment in both Saudi Arabia and the Arabian Gulf.
Desalination, vol. 33, no. 1, p. 99-107, 1980.

The author describes operational experience with various materials of construction in both low temperature polyphosphate treated evaporators and also in high temperature evaporators using acid treatment. The author references the repeated use of unsuitable materials and proposes a solution by the development of more detailed and positive specifications for plant and equipment. A problem faced by many manufacturers is the fact that as a result of broad, open specificatons they are forced to use inferior materials in order to remain competitive. The author discusses the use of both corrosion resistant linings and operating experience. In summary, the paper correlates the operating conditions with selection of materials.
Index terms: desalination plants/construction materials/ materials/corrosion control/Saudi Arabia/ISW, Persian Gulf

74. Tentrop, J.
The measurement of vibrations and supervising the running of pumps.
Chem.-Anlagen Verfahren, vol. 16, no. 2, p. 79-80, 1983.

The installation for monitoring pump vibrations in the new pipelines currently being built to supply Saudi Arabia with drinking water obtained from a sea-water desalination plant in the Persian Gulf, are described in detail. Three types of measuring chain with an automatic monitoring function are illustrated. (A.P.)
Index terms: condition monitoring/vibration monitoring

75. Tidball, R.A.; J.G. Gaydos, and W.M. King (Baldwin-Lima-Hamilton Corp., Philadelphia, Pennsyvania)
Operating experiences of one mgd desalination plant on the Red Sea.
Proceedings of the Symposium on Western water and power. 1968. p. C43-C49.

A one mgd desalting plant was erected in conjuction with a 6700 kilowatt steam generating station in Eilat, Israel. The design, manufacture and construction of the plant are discussed. The operating history and performance of the first 2 1/2 year period are summarized. The effects of brine chemistry on corrosion, scaling and heat transfer are discussed with methods of selecting proper operating conditions. No calcium nor magnesium scale deposits have formed at any point in the system. The results of the corrosion tests, chemical analyses and visual inspection indicate that the plant should have an operating life in excess of thirty years. From December 21, 1965 to December 30, 1966 the plant produced 349 million gallons or 93% of the design capacity on a continuous basis. On a daily basis, the plant actually averaged 110% of design capacity. However, scheduled downtime for maintenance, along with periods when there was no demand for water, reduced the total annual production. From January 1, 1967 to the present, the plant has averaged about 105% of design.
Index terms: flash distillation/thermal power plants/water costs/ economics/distillation/corrosion/desalination processes/ desalination plants/ Eilat (Israel)

76. Ukayli, M.A., and T. Husain (Dep. Earth Sci., King Fahd Univ. Petrol. and Min., Dhahran - 31261, Saudi Arabia)
Comparative evaluation of surface water availability, wastewater reuse and desalination in Saudi Arabia.
WATER INT, vol. 13, no. 4, p. 218-225, 1988.

There is a growing concern in the Kingdom of Saudi Arabia to exploit water resources of acceptable quality to meet demands in

domestic, industrial, and agricultural sectors. The agricultural water need constitutes approximately 84% of the total demand. Various alternative supplies to meet these demands are surface water, renewable groundwater resources, reclaimed wastewater, desalinated water and non-renewable groundwater. Due to excessive withdrawal of water from deep aquifers, considerable drawdown has recently been noticed. This paper reviews the existing and future trends in developing surface water resources, reclamation of wastewater from various towns and cities and its use, and the role of desalination plants in the coastal regions of the Arabian Gulf and Red Sea. These alternatives are evaluated and compared in economic terms.
Index terms: resource management/water management/water resources/water reclamation/desalination/water use /Saudi Arabia

77. Van Dijk, J.C., and J. Oomen (DHV Consulting Eng., Amersfoort, The Netherlands)
Design of the Dhahran reverse osmosis treatment plant. Proceedings of the 7. International Symposium on Fresh Water from the Sea. 1980. p. 355-368.

The design of the Dhahran Drinking Water Plant, a Reverse Osmosis plant with a capacity of 135 m super(3)/h (600 USGPM) is discussed. A combined design and research approach was followed to provide a fail-safe and trouble-free plant. The following aspects of this approach are elucidated: - field investigations into problem causing features of the existing RO plant in Dhahran - pilot-plant investigations into the feasibility of the selected pretreatment processes - optimization and automation of the operation of the treatment plant.
Index terms: desalination plants/sea water/ISW, Persian Gulf/ ISW, Saudi Arabia, Dharan/design

78. Wilf, M., and P. Glueckstern (Mekorot Water Company. 9 Lincoln St. Tel-Aviv, Israel)
Restoration of commercial reverse osmosis membranes under field conditions.
DESALINATION. Proceedings of the 2. World Congress on Desalination and Water Re-use. 1985. pp. 343-350, Volume 1 of 3.

A membrane restoration program was conducted at the site of a large (over 3 MGD) reverse osmosis brackish water desalting plant near Elat, Israel on the shore of the Red Sea. The procedure applied consisted of cleaning the membranes with an

alkaline solution at low pressure followed by dosing with a coloidal solution of high molecular weight of polymers at high pressure. The initial restoration tests were performed on single 8" elements, which were taken out from the commercial desalting unit due to the excessive salt passage. After obtaining positive results with a few single elements, the restoration procedure was applied on the elements as installed in the desalting units. One of the units, equipped with 8" and 10" hollow fiber elements, had an average salt passage of 14%. Following the restoration it was reduced to a level of 6% to 10% and was maintained at that level for several thousand operating hours by applying continuous online treatment. The reduction of salt passage was accompanied by a decrease of approximately equals 10% in productivity.
Index terms: desalination plants/reverse osmosis/membranes/ brackish water/water supply /ISW, Israel, Elat /restoration

79. Wilf, M.; M. Konstantin, and A. Chencinsky (Mekorot Water Co. Ltd., Tel-Aviv, Israel.)
Evaluation of an ion exchange system regenerated with seawater for the increase of product recovery of reverse osmosis brackish water plant.
Desalination, vol. 34, no. 3, p. 189-197, 1980.

An experimental ion exchange unit was operated on the Red Sea shore. Softening of the reject containing 1400 ppm calcium from a nearby RO brackish water plant was performed using seawater as regenerant. The experimental results reported show that the calcium concentration in the softened reject was reduced to a level which enables further RO desalting of the reject at 50% product recovery. A preliminary economic evaluation of 4000 m SUP-3 /day RO plant indicates that desalting of softened reject would be more economically advantageous than the continued operation of the existing thermal seawater desalting plants and should precede the commercial RO seawater desalting at this location.
Index terms: ion exchange/desalination processes/brackish water/ sea water/reverse osmosis

80. **Wind, solar energy plants.**
Al Ahram, p. 8, Nov. 24, 1987,.
The wind-powered ice factory in Abul Ghussoun at the Red Sea have been put Monday, November 23 in latest test operation. According to Maher Abadha, the Egyptian Min of Electricity, the factory which

was developed in cooperation with the UN Development Programme shall produce 4,000 ton a day. The wind energy power is put at 55 kw. Dr Talat Tablawi, Dir of New Energy Authority has said a new solar-powered 10-cu m per a day of sea water desalination plant in the same area was also put on trial operation. He pointed out that the 1st wind-powered desalination plant with an output of 30 cu m an hr was currently operational in Oweinat East. The plant was completed in technical cooperation of FRG
Index terms: Egypt/Energy--Solar Energy--Non Traditional Energy/ Industry -- Water Industry

III. Ocean Circulation

1. Allouc, J. (Ec. Natl. Sup. Geol., Lab. Sedimentol., Subst. Utiles et Energ., BP 452, 54000 Nancy Cedex, France)
Subsea encrustations in the Eastern Mediterranean: A genetic explanation = Les encroutements sous-marins de Mediterranee Orientale: Une explication genetique.
REV. INST. FR. PET, vol. 41, no. 3, p. 351-376, 1986.

Subsea incrustations or hardened sea floors are not specific to the Mediterranean, but they are particularly abundant there, especially in the eastern basin. They cover the slopes of subsea relief features and represent an example of surface diagenesis linked to periods of absence of sedimentation. Several types of incrustations can be distinguished, mainly as a function of the thickness of the indurated part (called limestone) and the general color of the material. Such limestone usually overlies a more or less soft mud. The induration (or lithification) of this mud results from the formation of a magnesian calcite cement, and different phases of the process can be distinguished by the nannostructure of the limestone. The phenomenon seems to be purely physicochemical and probably results from the combination of several factors such as the presence of deep currents, sufficiently high oversaturation with regard to nonmagnesian calcite, and very small concentrations of crystal growth inhibitors other than magnesium. Although it affects materials of varying ages, this form of subsea diagenesis seems to be mainly Quaternary.
Index terms: bottom topography/lithification/diagenesis/ concretions/ocean circulation/calcite /MED, Eastern Mediterranean

2. Anati, D.A. (Weizmann Inst. Sci., Dep. Isot. Res., Rehovot, Israel)
A parametrization of the geometry of the sea straits.
Oceanol. Acta, vol. 3, p. 395-397, 1980.
Index terms: Mediterranean Sea/Red Sea/paleoclimatology/ oceanography/ocean circulation/Pleistocene/Gulf of Aqaba/Bab-el-Mandeb/Strait of Gibralter/Strait of Tiran/Gordon Reef/Jackson Reef/Quaternary/Cenozoic/changes of elvel/salinity/water balance/ Froude conditons/evaporation/channel geometry

3. Anati, David A., and Robert C. Thunell (Weizmann Inst. Sci.,

Dep. Isot. Res., Rehovot, Israel)
Red Sea salinity.
Nature (London), vol. 339, p. 20-21, 1989.
For reference to original see Thunell, R.C., et al., Nature, vol. 334, p. 601, 1988.
Index terms: Red Sea/paleogeography/Red Sea region/oceanography/ocean circulation/ocean floors/Quaternary/stratigraphy/changes of level/Indian Ocean/salinity/paleosalinity/glacial environment/environment/paleo-oceanography/bottom features/paleocirculation

4. Andrie, C.
(Use of helium-3 and tritium tracers in oceanography); Utilisation des traceurs Helium 3 et Tritium en oceanographie.
Thesis. Paris, France, Inst. Francaise Rech. Sci. Dev. Coop., ORSTOM. 1987, 340 p.

This work is a synthesis of data about the use of helium and tritium as tracers regarding deep circulation in the Red Sea, Western Mediterranean Sea, and the north eastern Atlantic. The utilized data have been obtained by mass spectrometry.
Index terms: ocean circulation/tritium/helium/tracers/mass spectroscopy/ANE, North Atlantic/ISW, Red Sea/MED/tracer techniques

5. Andrie, C., and L. Merlivat (Lab. Geochim. Isot., CEA/IRDI/DESICP, 91191 Gif-sur-Yvette Cedex, France)
Contribution of deuterium, oxygen-18, helium-3 and tritium isotopic data to the study of the Red Sea circulation. = Contribution des donnees isotopiques de deuterium, oxygene-18, helium-3 et tritium, a l'etude de la circulation de la Mer Rouge.
OCEANOL. ACTA, vol. 12, no. 3, p. 165-174, 1989.

Deuterium, oxygen-18, helium-3 and tritium have been measured in samples collected during the Merou cruise in July 1982. The stable isotopeş D and super(18)O, associated with salinity data, describe a three-layered structure from the Bab-el-Mandeb straits to 15 degree N. A study is made of the evaporation-precipitation ratio E/P. The helium-3 data constitute important constraints relative to the deep and intermediate circulation. A hydrothermal source sampled near 21 degree N is responsible for the helium-3 enrichment of the deep waters to the South. Throughout the basin, an intermediate maximum in the super(3)He content of the waters is probably the result of a northward

return flow with its centre at a depth of 600-800 m. All the isotopic data show that the waters outflowing towards the Indian Ocean are principally composed of subsurface waters coming from the North at the Bab-el-Mandeb depth.
Index terms: tracer techniques/oxygen isotopes/helium isotopes/ tritium/hydrothermal activity/ocean circulation/ISW, Red Sea/ isotope dilution/deuterium

6. Anonymous
A collection of reprints.
Baton Rouge, LA, : La. State Univ., Coast. Stud. Inst., 1984. variously paginated
Individual reports are not cited separately, reprints of La. State Univ., Coast. Stud. Inst. Technical Reports No. 375, 387, 388, 389, 391, 392, 394, 395, 396, and 397 published elsewhere
Index terms: Gulf of Mexico /oceanography/marine geology/coastal environment/sedimentation/ocean circulation/reefs/continental shelf/general/observations/Nicaragua/Central America/Cayman Islands/West Indies/North American Atlantic/North Atlantic/ Atlantic Ocean/Florida/Southeastern U.S./Eastern U.S./United States/Red Sea/Indian Ocean/Louisiana/Southern U.S.

7. Babcock, A.L., and S.P. Murray (Tetra Tech, Inc., 666 North Rosemead Blvd., Pasadena, California)
Characteristics of tidal Reynolds stresses and low-frequency turbulence in the Tiran Strait.
EOS TRANS. AM. GEOPHYS. UNION. Spring Meeting, American Geophysical Union Baltimore, MD (USA) 31 May 1983, vol. 64, no. 45, p. 741, 1983.

The Tiran Strait, the entrance into the Gulf of Aqaba at the northern end of the Red Sea, has sill depths of similar to 300 m and similar to 100 m in its two main passages, Enterprise and Grafton, respectively. Each passage is only similar to 1 km across and several kilometers long. An observation program (12 current meters on 5 moorings, STD transects, etc.) in the winter of 1982 has shown that intense evaporation in the Gulf drives a two-layered thermohaline mean circulation, the details of which have already been described. Lateral Reynolds stresses and other properties of low-frequency turbulence have been computed from the current meter data in the tidal and supratidal ($0.3 < f < 3$ cph) bands. The tidal stress (U sub(o)V sub(o)) is consistently an order of magnitude larger than the turbulent (supratidal) stress. Cross correlations of along-channel speeds U sub(o)

between vertical and lateral current meter pairs indicate a significant frictionally induced lag in both pairs, but vertical friction is slightly dominant. Both tidal and supratidal stresses are more than an order of magnitude more energetic during spring as compared to neap tides.
Index terms: ocean circulation/Reynolds stresses/turbulence/ISW, Aqaba Gulf, Tiran Strait

8. Bethoux, J.P. (Lab. de Phys. et Chimie Marines, Univ. Paris-VI, UA CNRS, Villefranche-sur-Mer, France)
Variabilite climatique des echanges entre la Mer Rouge et l'Ocean Indien. [Climatic variability of transports between the Red Sea and the Indian Ocean.].
Oceanologica Acta, Paris, vol. 10, no. 3, 285-291, July 1987.

Study of the heat budget of the Red Sea, a concentration basin semienclosed by the sills and straits of Bab al Mandab, permits evaluation of the annual evaporation, which, with other elements of the water and salt budgets, permits, in turn, a determination of mean transports. The seasonal cycle of the water budget is calculated from the seasonal cycle of evaporation (evaluated from mean annual values and from meteorological data) and from monthly sea level data. During winter, the outflow of dense Red Sea water is strengthened by the occurrence of light-density water in the Gulf of Aden, advected by the Northeast monsoon. Inversely, in summer, the concentration basin dynamics are disturbed by the inflow of subsurface water from the Gulf of Aden. Determination of the heat content of the surface layer (0-150 m) permits evaluation of the extension, volume, and spatial-temporal behavior of this subsurface water. Linked to the summer monsoon in the Indian Ocean, which provokes an upwelling and an increase in subsurface water density in the Gulf of Aden, this water inflows to 18"N lat. then outflows back from the Red Sea when the summer monsoon decays. The seasonal cycle of transports through the Strait of Bab al Mandab shows the monsoon driving force effects superimposed upon the concentration basin transports, and the probable effect of the monsoon interannual variability. The zonal differentiation that occurs at APPROX. 18"N as a result of topography and climate is, thus, strengthened by hydrology and water masses. Dynamic or geochemical studies must take into consideration this zonal differentiation, which is influenced by the movement of Aden subsurface water and has biological implications.
Index terms: Oceanic circulation/Oceanic transfers/Indian Ocean/

9. Bignami, F.; N. Conenna; M. Ostili; G. Palmieri, and B. Palombo (Rome Univ. (Italy). Ist. di Fisica)
(Preliminary report of hydrological measurements carried out in the southern Adriatic Sea: Palma 86 Campaign.); Rapporto preliminar sui risultati delle misure idrologiche eseguite in Adriatico Meridionale: Campagna Palma 86. 1987.
NTIS Order No.: N88-14597/4/GAR.

The results of an oceanographic campaign carried out as part of the physical oceanography of the Eastern Mediterranean project are presented. The goal is the study of ocean circulation, its causes, and impact. The measurement system includes a CTD bathymeter, a Loran C system, and a data acquisition system based on Zilog Z80 microprocessor.
Index terms: MED, Adriatic/research programs/CTD observations/ ocean circulation/geostrophic flow/cruises/hydrography

10. Brenner, S. (Israel Oceanogr. and Limnol. Res., Natl. Inst. Oceanogr., Haifa, Israel)
Structure and evolution of warm core eddies in the eastern Mediterranean Levantine Basin.
J. GEOPHYS. RES. (C OCEANS), vol. 94, no. C9, p. 12593-12692, 1989.

Two recent cruises of the R/V Shikmona provided detailed coverage of a large portion of the Levantine Basin of the eastern Mediterranean. The first cruise was conducted in October 1985, corresponding to late summer, and the second was in March 1986, corresponding to the following winter. An objective analysis of the combined conductivity-temperature-depth and expendable bathythermograph data from these cruises reveals a variety of warm core and cold core mesoscale eddies both seasons. Two intense anticyclonic eddies were identified. One of these appears to have formed off the coast of Egypt as a meander of the North African current. The other is a rather persistent quasi-stationary feature to the southeast of Cyprus.
Index terms: MED, Levantine Basin/dynamical oceanography/ocean circulation/mesoscale eddies/CTD observations/ bathythermographic data/water masses/summer/winter

11. Brewer, P.G. and D. Dyrssen.
Chemical oceanography of the Persian Gulf.
Crease, J.; Gould, W. J.; Saunders, P. M., editors.
Essays on oceanography; a tribute to John Swallow.
Woods Hole, MA, : Woods Hole Oceanogr. Inst., 1984.

vol. 14, p. 41-55, (Progress in Oceanography)
Index terms: Persian Gulf/sea water /oceanography/composition/ salinity/Arabian Sea/Indian Ocean/nutrients/alkalinity/chemical composition/upwelling/phosphate ion/bathymetry/Gulf of Oman/ Straits of Hormuz/Iran/Middle East/Asia/Saudi Arabia/Arabian Peninsula/ocean circulation/sampling

12. Burkov, V.A.; V.I. Kuksa, and V.N. Dyadyunov (Inst. Okean. im. P. P. Shirshova AN SSSR; Gosud. Nauchno-Issled. Tsentr, Izucheniya Prirodnykh Resursov Gosud.Komiteta, Gidromet. i Kontrolya Prirodnoy Sredy SSSR; Gosud. Nauchno-Issled. Tsentr. Izucheniya Prirodnykh Resursov Gosud.Komiteta, Gidromet. i Kontrolya Prirodnoy Sredy SSSR)
Vliyaniye promezhutochnykh vod na tsirkulyatsiyu mirovogo okeana. [Influence of intermediate waters on the World Ocean circulation.]
Okeanologiya, Moscow, vol. 19, no. 4, p. 576-583, July/Aug. 1979.

The influence of intermediate waters upon the circulation in the World Ocean is considered. The intermediate waters of high salinity (Mediterranean Sea, Red Sea, Arabian Sea, and circumpolar waters) weaken the wind- generated circulation, whereas the low salinity waters (Antarctic, North Pacific), on the contrary, intensify the circulation by favoring its stability and development into depth. The above-mentioned difference is strengthened by the effect of density increase in the process of seawater mixing.
Index terms: Oceanic circulation dynamics/Intermediate waters

13. Carlson, E. D.
Gulf of Oman abyssal sands transported from Persian Gulf.
Thesis. Ithaca, NY, Cornell University. 1982, 33 p.
Index terms: Persian Gulf/sedimentation/sediments/Arabian Sea/ oceanography/transport/turbidity currents/provenance/quantitative analysis/Indian Ocean/Gulf of Oman/marine transport/ocean floors/ oolitic texture/Zagros Foreland/shallow-water environment/Strait of Hormuz/sand/clastic sediments/calcite/carbonates/quartz/silica minerals/framework silicates/silicates/continental slope/ocean circulation

14. Cember, Richard Paul.
Two oceanographic studies in the Red Sea.
Dissertation. New York, NY, Columbia University. 1988, 163 p.
Index terms: Red Sea/carbon/isotopes/oceanography/ocean

circulation/C-14/C-12/Indian Ocean/seasonal variations/upwelling/ mixing/corals

15. Collins, M.B., and F.T. Banner
Secchi disc depths, suspensions, and circulation, northeastern Mediterranean Sea.
Marine Geology, Amsterdam, vol. 31, no. 1/2, p. M39-M46, 1979.

The distribution of surface suspensions supports previous postulates of offshore circulation in the northeastern Mediterranean, but also indicates a quasi-permanent, cyclonic gyre in the Bay of Mersin with convergence and divergence zones south of the bay. Figures include a northeastern Mediterranean circulation map.
Index terms: Transparency of seawater/Suspensions in seawater/ Oceanic circulation/ Oceanic gyres/Eastern Mediterranean

16. El-Gindy, A.A. H., and S.H. S El-Din (Oceanogr. Dep., Fac. Sci. (Moh. Bey), Alexandria Univ., Alexandria, Egypt)
Water masses and circulation patterns in the deep layer of the eastern Mediterranean.
OCEANOL. ACTA, vol. 9, no. 3, p. 239-248, 1986.

Hydrographic data collected at deep stations during the cool and warm seasons from 1948 to 1972 were used for detailed analysis of the water masses and circulation patterns at and below 1,000 m depth. The potential temperature, salinity, potential density distributions and mixing ratios of Adriatic, Levantine and Cretan waters at 1,000 and 2,000 m depth were presented. Two water cores were found, one with low salinity and temperature and a significantly high percentage of Adriatic-type water (greater than 80%), less than 10% of deep Cretan Sea water, and 10 to less than 20% of Levantine-type water. The other is found near the Cretan Sea straits with an important contribution of deep Cretan Sea water (about 40-50%), 40-60% of Adriatic and 5-15% of Levantine-type water.
Index terms: water masses/hydrography/ocean circulation/water mixing/deep layer/ MED, Eastern Mediterranean

17. Farmer, A. and JE Docksey.
A Bibliography of the Marine and Maritime Environment of the Arabian Gulf and Gulf of Oman.
Kuwait Bulletin of Marine Science (Number 4) April 1983.

This bibliography attempts to be exhaustive and presents 1771 references in 121 pages. It covers the marine environment of the Arabian (Persian) Gulf, the lower reaches of river systems entering the basin, in particular the Shatt Al-Arab, and the Gulf of Oman. Not included are marine engineering, oil exploration and shipping, and voyage narratives.

18. Gerges, M.A.
Preliminary results of a numerical model of circulation using the density field in the eastern Mediterranean.
Acta Adriatica, Split, Yugoslavia, vol. 38, no. 1/23, p. 163-176, 1973/76.

A thermohaline circulation model in a baroclinic ocean is used to determine circulation at the surface and at 50, 100, 300, and 500 m. These levels are intended to represent the surface,intermediate, and deep circulation patterns in the Eastern Mediterranean. The general circulation from the surface to the baroclinic depth has the same cyclonic direction and is unidirectional; there is no reversed current in the deeper layers.
Index terms: Oceanic circulation models/Eastern Mediterranean

18. Frank, B. A.
STD Stations Aboard the USNS Lynch.
Quarterly Micropalentology of the Rub'al Khali, Saudi Arabia, June 1977.
Geographic Area - North Atlantic, Mediterranean Sea, Strait of Gibraltar.

Data contains measurements of salinity, temperature, depth, dissolved oxygen, and light scattering. Data collected by the Naval Research Lab, Ocean Floor Analysis Division aboard the USNS Lynch and will be forwarded to NODC 7/74.

19. Hecht, A., and D.A. Anati.
A description of the Straits of Tiran in Winter 1978.
Israel Journal of Earth Sciences, vol. 32, p. 149-164, 1983.
Index terms: Red Sea/oceanography/ocean circulation/Indian Ocean/ Gulf of Aqaba/salinity/temperature/statistical analysis/ thermohaline circulation/tidal currents/Straits of Tiran/Hiver 1978

20. Hopkins, T.S. (Brookhaven National Lab., Upton, NY)
Discussion of the Ionian and Levantine seas, NATO Workshop on Atmospheric and Oceanic Circulation in the Mediterranean Basin.
NATO Workshop on Atmospheric and Oceanic Circulation in the Mediterranean Basin Santa Tereasa (Italy) 7 Sep 1983, 42 p., 1983.

NTIS Order No.: DE84011562; CONF-8309237-1
The Levantine Intermediate Water (LIW) is the most critical water mass in the thermohaline heart of the Mediterranean. It is comprised of North Atlantic Water (NAW) which was transformed to salty water (36.2 to 39.2 ppt). In the eastern Mediterranean (EMED) the NAW changes to a warm saline surface layer and a cool less saline layer. Much of the LIW is produced from winter cooling of surface waters. The distribution is patchy, dependant on original surface type, circulation, and atmospheric exposure. Convective depths range to 400 m the densest water not necessarily correlated with the deepest convective layers. Survival of the LIW depends on circulation and density.
Index terms: ocean circulation/ocean-atmosphere system/water masses/conferences/MED, Ionian Sea/MED, Levantine Sea

21. Lacombe, H.
L'oceanographie physique de la Mer Rouge; symposium de l'association Internationale de Sciences Physiques de l'Ocean Physical oceanography of the Red Sea; symposium of the International Association of Physical Sciences of the Ocean. L'oceanographie physique de la Mer Rouge Fr., Cent. Natl. Exploit. Oceans, Publ., Actes Colloq. 1974. 312 p.
Individual papers are not cited separately. Conference held in Paris, France, Oct. 9-10, 1972.
Index terms: symposia/Red Sea /oceanography/ocean circulation/sea water/temperature/transport/sedimentation/variations

22. Lardner, R.W.; A.H. Al-Rabeh; N. Gunay, and H.M. Cekirge (Dep. Math., Simon Fraser Univ., Burnaby, B.C. V5A 1S6, Canada)
Implementation of the three-dimensional hydrodynamic model for the Arabian Gulf.
ADV. WATER RESOUR, vol. 12, no. 1, p. 2-8, 1989.

A three-dimensional hydrodynamic model for the Arabian Gulf has been developed by Lardner and Cekirge. In this paper, certain implementation aspects of the model are discussed. In particular, appropriate values for the hydrodynamic model parameters are proposed. An interpolation scheme to generate surface current velocities at off grid points is proposed.
Index terms: ISW, Persian Gulf/hydrodynamics/ocean circulation/ shallow water/tidal currents/wind-driven currents/mathematical models/dynamical oceanography

23. Lardner, R.W.; M.S. Belen, and H.M. Cekirge

Finite difference model for tidal flows in the Arabian Gulf.
Computers & Mathematics with Applications, vol. 8, p. 425-444, 1982.
Index terms: Persian Gulf/Qatar/Bahrain/oceanography/ocean circulation/mathematical models/models/two-dimensional models/ finite difference analysis/statistical analysis/hydrodynamics/ bays/tidal currents/equations/Arabian Sea/Indian Ocean/Arabian Peninsula/Asia/shore features

24. Levine, E.R., and W.B. White (Rhode Island Univ., Graduate School of Oceanography, Kingston, RI.)
Thermal frontal zones in the eastern Mediterranean Sea.
Journal of Geophysical Research, vol. 77, no. 5, p. 1081-1086, Feb. 1972.

From August 7 to October 4, 1966, near-surface temperature measurements in the eastern Mediterranean Sea were taken on Cruise 61 of the R.V. Chain. These measurements consisted of towing a constant-level, continuously recording temperature sensor behind the ship and were supplemented by bathythermograph lowerings taken every 2 hours. Visual inspection of these data shows that near-surface horizontal temperature changes along the cruise track were not continuous, but rather occurred in an approximate stepwise fashion at 20 locations, where the temperature gradient exceeded 1 C/10 km either at the surface or in the seasonal thermocline. The geographical distribution of the locations of these gradients suggests that the ship made 19 crossings of two long thermal frontal zones. One frontal zone was located in the Ionian Basin and the other in the Levantine Basin; both appear to have separated the warm water adjacent to the coast from the colder water in the interior of the basin. These two frontal zones may have been continuous and associated with the general counterclockwise circulation around the Eastern Mediterranean Basin.
Index terms: oceanography/thermocline/water temperature/ geophysics/thermal properties/density/coasts/ocean currents/ocean circulation/thermometers/bathymetry/mapping/bathythermographs

25. Luz, B., and L. Perelis-Grossowicz
Oxygen isotopes, biostratigraphy and Recent rates of sedimentation in the eastern Mediterranean off Israel.
Isr. J. of Earth-Sciences, vol. 29, p. 140-146, 1980.
ICGP Project No. 001.
Index terms: Israel/foraminers/oxygen/isotopes/sedimentation/

sediments/Mediterranean Sea/stratigraphy/Holocene/ biostratigraphy/O-18/O-16/rates/indicators/marine sediments/ distribution/oceanography/ocean circulation/Middle East/East Mediterranean/planktonic taxa/Quaternary/ratios/sapropel/organic materials/paleo-oceanography/marine environment/marine sedimentation/paleocirculation

26. Maillard, C., and G. Soliman (IFREMER, Cent. Brest, BP 337, 29273 Brest Cedex, France)
Hydrography of the Red Sea and exchanges with the Indian Ocean in summer.
OCEANOL. ACTA, vol. 9, no. 3, p. 249-269, 1986.

A cruise was carried out on board the R.V. Marion Dufresne in 1982 to follow the summer Red Sea regime and estimate the exchanges of water with the Indian Ocean. Two hydrographic surveys were made: one in early summer (June-July), the other in late summer (September-October). Between the two legs, a mooring of current meters was anchored in the Bab al Mandab Strait. Accordingly the three-layer summer stratification was clearly observed in the Bab al Mandab Strait in June, and up to 18 degree N in October. Simple empirical models are used to interpolate the depth of the interfaces in the Bab al Mandab Strait between the two surveys and, at a given time, to obtain the vertical profile of the velocity.
Index terms: hydrography/water masses/water exchange/layers/ stratification/vertical profiles/ocean circulation/summer/ISW, Red Sea, Bab al Mandab Strait/ISW, Indian Ocean

27. Malanotte-Rizzoli, P., and A. Hecht (Dep. Earth, Atmos. and Planet. Sci., 54-1420, Cent. Meteorol. and Phys. Oceanogr., Massachusetts Inst. Technol., Cambridge, MA 02139)
Large-scale properties of the Eastern Mediterranean: A review.
OCEANOL. ACTA, vol. 11, no. 4, p. 323-335, 1988.

A review is provided of the present state of knowledge of the Eastern Mediterranean, including both its phenomenology (general circulation, water masses, specific local processes) and the theoretical efforts devoted to modelling these properties.
Index terms: ocean circulation/wind pressure/water masses/ literature reviews/bottom topography effects/models/MED,

28. Metzl, Nicolas; BerrienIII Moore; Anne Papaud, and Alain Poisson

Transport and carbon exchanges in Red Sea: inverse methodology.
Global Biogeochemical Cycles, vol. 3, p. 1-26, 1989.
Index terms: Red Sea/geochemistry/carbon/sea water/sedimentation/ organic materials/geochemical cycle/processes/chemical sedimentation/Indian Ocean/carbon dioxide/carbonates/theoretical studies/mathematical models/models/biochemical sedimentation/ marine environment/environment/ocean circulation/marine transport

29. Miller, A. R. et al.
Hydrographic Data from Red Sea Deep Water Casts and Mineralogy of Sediments Collected from Atlantis II Deep and Discovery Deep.
Hot Brines and Recent Iron Deposits in Deeps of the Red Sea.
Woods Hole Oceanographic Institution, Woods Hole, MA, 1965.
Geographic Area - Africa, Red Sea.

Hot brines relatively rich in dissolved heavy metal concentrations have been found in the central Red Sea at depths of approximately 300 meters in two small pools 2 to 5 miles in extent. Associated bottom deposits indicate an intriguing geochemical system wherin dissolved minerals in an acidic environment are precipitating upon contact with the normal alkalinity of Red Sea water. The brines are ten times saltier than normal with temperatures of 44 degrees to 56 degrees C. The sediments beneath the brines are rich with iron minerals up to 70% of their content with an abundance of other minerals as maganese and zinc.

30. Morcos, S.A.
The Egyptian expedition to the Red Sea 1934-1935.
Angel, M. V., editor.
Marine science of the north-west Indian Ocean and adjacent waters: Mabahiss/John Murray international symposium. Deep-Sea Research. 1984, vol. 31, p. 599-616, (Paleoceanographic Research Papers)
Index terms: Red Sea/oceanography/marine geology/Indian Ocean/ Egypt/North Africa/Africa/expeditions/history/reefs/sediments/ bathymetry/continental shelf/temperature/salinity/oxygen/hydrogen ion/phosphate ion/ocean circulation/thermohaline circulation/ currents

31. Morcos, S.A., and Moustafa-Hassan Hassan
Water masses and circulation in the southeastern Mediterranean.
Acta Adriatica, Split, Yugoslavia, vol. 38, no. 1/23, p. 219-235, 1973/76.

A layer of subsurface minimum salinity (50-75 m) appears along the Egyptian coast and develops under the influence of the

Atlantic Ocean Surface Current flowing eastward from Gibraltar. An alternative source is inferred from this data from 205 oceanographic stations where the layer of subsurface minimum salinity in August can be traced to the surface, less saline layer of the preceding spring. The intermediate maximum salinity layer appears as a tongue of high salinity between 150 and 300 m, with a tendency to become deeper and less saline toward the west. It is generally accepted that the source of this layer is in the surface water of the northern part of the Levant Sea from where it sinks in winter and spreads toward the south and west. The intermediate maximum salinity layer is formed locally during winter and becomes better defined in summer and autumn. At least two alternative or combined sources contribute to the formation of the subsurface minimum salinity layer and the intermediate maximum salinity layer. Further investigations of the processes and sources of formation of both layers are required.
Index terms: Salinity stratification/Ocean water masses/Oceanic circulation/Eastern Mediterranean

32. Murray, S.P. and H.H. Roberts
Control of accretion processes on Tiran Strait sill by evaporation-driven current dynamics.
AAPG annual convention with divisions; SEPM/EMD/DPA. AAPG Bulletin. 1984, vol. 68, p. 511.
Index terms: Red Sea /oceanography/ocean circulation/geophysical surveys/surveys/Indian Ocean/Gulf of Aqaba/Strait of Tiran/ carbonate platforms/Sinai/Saudi Arabia/Arabian Peninsula/Asia/ Strait of Gibraltar/seismic surveys/geophysical profiles/side-scanning methods/sonar methods/acoustical surveys/reefs/patch reefs/cement/carbonate rocks/evaporation/sedimentation/controls

33. **NAPIS 72-0228 - Currents Persian Gulf.**
User Services Branch National Oceanographic Data Center National Environmental Satellite, Data and Information Service NOAA, Washington, DC 20235, Jan. 1951 - August 1952.
Geographic Area - Indian Ocean, Persian Gulf, Ras-Kaliya, Jubail.
File contains surface and subsurface currents for the Persian Gulf. Tidal currents were measured at the surface using drift pole and subsurface using Price and Ekman meters. Data collected using U.S.S. Allegheny and U.S.S. Stallion.

34. **NAPIS 72-0231 - Persian Gulf Current Data.**
User Services Branch National Oceangraphic Data Center National Environmental Satellite, Data and Information Service NOAA,

Washington, DC, Dec. 1949 - April 1950.
Geographic Area - Indian Ocean, Persian Gulf, Arabia, Ras-Tanura Harbor, Kubar Island, Fabihil, Khawr-El-Ama, Ammal-Al-Maradin.

File contains surface and subsurface current observations from the Persian Gulf. 9 stations were sampled for a period of about 3 days each. Price current meters were used for subsurface current speeds, drift pole observations were used for surface observations. Data gathered using U.S.S. Stallion.

35. **NAPIS 72-0252 Tidal Currets in Persian Gulf.**
User Services Branch National Oceanographic Data Center National Environmental Satellite, Data and Information Service NOAA, Washington, DC. Nov. 1948 - March 1960.
Geographic Area - Indian Ocean, Persian Gulf, Arabia, Kuwait Harbor.

File contains records of 97 current stations taken in various parts of Persian Gulf. Most data were at surface and subsurface, 4-8 feet. Methods used were Price current meter for subsurface speeds and drift pole for surface data. Data collected using U.S.S. Stallion and U.S.S. Allegheny.

36. **NAPIS 74-0263 Persian Gulf Surface Chemistry and Physical Measurements.**
User Services Branch National Oceanographic Data Center National Environmental Satellite, Data and Information Service NOAA, Washington, DC, Jan. 1945 - July 1973.
Geographic Area - Indian Ocean, Arabian Sea, Persian Gulf, Turak Bay, Half-Moon Bay, Ras-Tanura.

Measurements included are sea surface temperature, salinity, sodium, magnesium, silicate, chlorine, bicarbonite ion, and total solids. The chemical parameters were only measured in 1972 and 1973 with the methods of measurements unknown. Data collected by the Arabian American Oil Company at 4 locations near their oil refinery operations.

37. Neumann, A. C. and Dana Densmore.
Oceanographic Data from Mediterranean Sea, Red Sea, Gulf of Aden and Indian Ocean. Atlantis Cruise 242 for the International Geophysical Year 1957-58.
Lamont Geological Observatory, Woods Hole, NTIS, Palisades, NY 1964, 1960.

Geographic Area - Indian Ocean, Gulf of Aden, North Atlantic Ocean, Mediterranean Sea, Africa, Red Sea, Gulf of Suez, Suez Canal.

In the summer of 1958 R/V Atlantis of the Woods Hole Ocanographic Institution

and R/V Vema of the Lamont Geological Observatory conducted seismograph studies in the Mediterranean Sea, Red Sea, Gulf of Aden and Indian Ocean. Data of 51 hydrographic stations plus a list of surface salinity and temperature values are presented.

38. Nolet, G.J., and B.H. Corliss (EXXON Co. U.S.A., Houston, TX)
Benthic foraminiferal evidence for reduced deep-water circulation during sapropel deposition in the Eastern Mediterranean.
MAR. GEOL, vol. 94, no. 1-2, p. 109-130, 1990.

An analysis of deep-sea foraminifera from six eastern Mediterranean piston cores was carried out to determine the faunal response to the deposition of sapropel S5, formed between 125,000 and 116,000 yrs B.P. The pre-S5 population is the most diverse, being composed of miliolids, Articulina tubulosa, Gyroidina spp., and various rotaliids. An assemblage found near the base and top of S5 is dominated by Chilostomella mediterranensis, Globobulimina affinis , and Bolivina spp, and the post-S5 fauna is dominated by A. tubulosa and Gyroidina spp. The faunal data are interpreted in terms of the microhabitat preferences of the fauna, based on living (stained) benthic foraminiferal data and associated morphological characteristics from the North Atlantic. Epifaunal species dominate pre-S5 and post-S5 sediments and are associated with low organic carbon values ranging from 0.1 to 0.4%. Infaunal species, occurring near or within sapropel layers, are found with organic carbon values of > 0.7% and live in environments characterized by low dissolved oxygen levels.
Index terms: sapropels/anoxia/micropalaeontology/ paleoceanography/community composition/microhabitats/abyssal circulation/ocean circulation/substrate preferences/food availability/salinity effects/temperature effects;environmental factors/MED/foraminifera

39. Osman, M.M. (Alexandria Univ., Dept. of Oceanography, Alexandria, Egypt)
Water exchange between the Red Sea and Gulf of Aden.
International Symposium on the Most Important Upwelling Areas off Western Africa (Cape Blanco and Benguela) 1985. p. 205-212,.

The Red Sea is a semi-isolated body of water having no tributaries and negligible rainfall. Due to the arid climate of the area, evaporation from its surface is exceedingly high. The only significant water supply is from the Gulf of Aden. Accordingly, during any month the water budget of the sea is

determined mainly by the water exchange through the Strait of Bab-El-Mandeb, the amount of evaporation and month-to-month sea level variations. These facts are incorporated in a simplified model to estimate monthly net water volume transports. The obtained values are combined with monthly surface transports to determine monthly and annual transports of the inflowing and outflowing waters. The achieved results for the annual volumes of the inflowing and outflowing water are in good agreement with those obtained from Knudsen's Hydrographical Theorem. The examination of water and salt interchanges support the validity of the obtained results.
Index terms: Red Sea/Gulf of Aden/water exchange/water supply/ model studies/seasonal variation/upwelling/ocean circulation/ salinity

40. Ozsoy, E.; A. Hecht, and U. Unluata (Inst. of Marine Sci., Middle East Tech. Univ., Icel, Turkey; Israel Ocean. and Limnological Res. Ltd., Haifa; Inst. of Marine Science)
Circulation and hydrography of the Levantine Basin: results of POEM coordinated experiments 1985-1986.
Progress in Oceanography, N.Y., vol. 22, no. 2, p. 125-170, 1989.

A brief review of the meteorological setting, hydrography, and the circulation in the Levantine Basin of the Eastern Mediterranean is given. The recent high-resolution data obtained in POEM coordinated experiments of 1985-1986 are then used to estimate the circulation in the basin in two different seasons and to describe the water mass distributions. Some of the features observed during the experiments support the historical knowledge on the locations of subbasin scale gyres and the general circulation, in addition to which some new features are established. Details of the circulation, such as the intensity, the multiple scales, and the three-dimensional structure of the various vortices and the Central Levantine Basin Current are displayed extensively. A variety of subbasin, meso- and submesoscale vortices occur with highly asymmetric (baroclinic) vertical structures. Some eddies split into multiple centers with depth, interpreted as indicating possible coalescences. A number of long-lived eddies were persistent in both surveys. The subsurface Atlantic water (AW) is advected by and entrapped within the eddy field. The Levantine intermediate water (LIW) at intermediate depths is shown to be maintained throughout the year in the northeastern sector of the Levantine Basin and along the periphery of the Rhodes gyre. The Levantine intermediate

water also has a patchy distribution, owing to the advection and trapping by the eddy field which it helps to generate through adjustment processes.
Index terms: Oceanic circulation/Water mass distribution/Oceanic eddies/Intermediate waters/Eastern Mediterranean

41. Patterson, R. J.
Hydrology and Carbonate Diagenesis of a Coastal Sabkha in the Persian Gulf.
Princeton University, Princeton, NJ, 1971.
Geographic Area - South Shore Persian Gulf.

During the past 5000 years sedimentary offlap and a relative fall in sea level have resulted in the development of broad, gently sloping planar areas called sabkhas. These structures occur along much of the south shore of the Persian Gulf. The paper investigates the two hydrologic regimes present and the sabkhas and their interactions, wind-driven sheets of seawater speading thinly several kilometers inland and infiltrating the groundwater. The reactions result in the formation of various minerals. Observations were conducted from Jan. 1967 through July 1979.

42. Patzert, William C.
Seasonal variations in structure and circulation in the Red Sea.
Hawaii. Univ., Honolulu. Hawaii Institute of Geophysics, HIG-72-13, , 58 p. + appendix, Aug. 1972.

That variations in structure and circulation in the Red Sea along the N-S axis of the Sea from the Gulf of Suez to the Gulf of Aden are closely associated with wind stresses acting on the sea surface, is demonstrated in a study of the monthly mean variations occurring in the oceanographic structure and surface circulation in the Sea. The horizontal equations of motion are simplified, in accordance with observed conditions, to help understand the forces that drive the circulation of the Red Sea. Calculations of sea-surface topographies for each month along the central axis of the Sea show that surface flow is almost always with the wind against the slope of the Sea, which indicated that surface circulation is not primarily caused by the distribution of mass, but rather by the action of the wind.
Index terms: Seasonal oceanic circulation variations/Seasonal oceanographic variations/Oceanic structures/Red Sea

43. Patzert, William C. (Scripps Inst. of Ocean., La Jolla, CA.)

Seasonal reversal in Red Sea circulation.
In: L'Oceanographie Physique de la Mer Rouge, Symposium de l'Association Internationale des Sciences Physiques de l'Ocean (IAPSO), Actes de Colloque No. 2. CNEXO Publications, Paris, p. 55-89, 1975.
Univ. Honolulu. Hawaii Institute of Geophysics, Contributions, 1975. Honolulu, [1976], No. 500, p. 51-65.

The monsoon reversal in the Red Sea circulation is analyzed by presenting a monthly mean description of variations that occur in the oceanic structure and circulation in the upper 250 m of the Sea and how they are related to the winds acting at the sea surface. During winter (Oct. to May), the surface waters flow north, sink in the northern Red Sea, and return to the south as a warm, high-salinity subsurface current that flows out over the shallow sill into the Gulf of Aden. During summer (June-Sept.), the winter cellular flow pattern reverses; i.e., the surface waters of the Sea flow south, causing an upwelling of the structure in the northern Red Sea, while in the southern Red Sea, a subsurface inflow over the shallow sill of cool, low salinity Gulf of Aden water occurs. This reversal in circulation is closely associated with reversals in the monsoon winds acting at the sea surface in the southern Red Sea and Gulf of Aden.
Index terms: Seasonal oceanic circulation variations/Monsoon-oceanic circulation relationships/Red Sea

44. Patzert, WilliamC. (Scripps Inst. of Ocean., La Jolla, CA.)
Wind-induced reversal in Red Sea circulation.
Deep-Sea Research, Oxford, vol. 21, no. 2, p. 109-121, Feb. 1974.
Index terms: Wind effects on ocean circulation/Monsoon-oceanic circulation relationships/Oceanic circulation patterns/Red Sea

45. **Physical oceanography of the eastern Mediterranean: an overview and research plan : report of workshop held in Lerici, La Spezia (Italy), September, 1983.**
Paris, France : UNESCO, 1984. 16, [10] p.
Rockville: GC1.U35 no. 30

46. **Physical oceanography of the Eastern Mediterranean (POEM): a research programme : reports of the Organizing Committee meeting, Paris, August 1984, and the Scientific Workshop, Lucerne, October 1984.**
Paris, France : UNESCO, 1985. 67 p.
Rockville: GC1.U35 no. 35

47. **Physical oceanography of the Eastern Mediterranean (POEM); initial results.**
UNESCO/IOC First POEM scientific workshop. UNESCO Reports in Marine Science, 91 p., 1987.
Conference held at Erdemli, Turkey, June 16-20, 1986.
Index terms: Mediterranean Sea/symposia /oceanography/sea water/ East Mediterranean/ocean circulation/air-sea interface/eddies

48. **Physical oceanography of the eastern Mediterranean (POEM): programme for 1988/89.**
Paris, France : UNESCO, 1988. 21 p.
Rockville: GC1.U35 no. 51

49. Pickett, R.L.; R.M. Partridge; R.A. Arnone, and J.A. Galt (Nav. Ocean Res. Dev. Act., Bay St. Louis, MS, USA)
The Persian Gulf, oil and natural circulation.
SEA TECHNOL, vol. 25, no. 9, p. 23-25, 1984.

The Kingdom of Saudi Arabia requested the help of the U.S. government in analyzing the natural circulation of the Persian Gulf. The concern for Saudi Arabia was to find out whether the increasing spillage of oil into Gulf waters as a result of the Iran-Iraq war would be likely to end up on its shores and foul the desalination plants in the area. Oil particles, following the model circulation pattern at a mean speed of 20 cm/sec would require several months to travel the total length of the Persian Gulf. During such a trip, tidal and inertial currents would spread the oil with oscillations of about 10 to 20 kilometers. This wind and current combination should result in oil moving south and east from sources in the northern end of the Persian Gulf, and should preserve the desalination plants along the western shores from any adverse impact from the spills.
Index terms: fate/oil spills/ISW, Persian Gulf/pollution dispersion/satellite sensing/marine pollution/ocean circulation

50. Poisson, A.; S. Morcos; E. Souvermezoglou; A. Papaud, and A. Ivanoff (Lab. Phys. Chim. Mar., Univ. Pierre et Marie Curie, Tour 24, 4 Place Jussieu, 75230 Paris Cedex 05, France)
Some aspects of biogeochemical cycles in the Red Sea with special reference to new observations made in summer 1982.
DEEP-SEA RES, vol. 31, no. 6-8A, p. 707-718, 1984.
Mahabiss/John Murray International Symposium: Marine Science of the North-West Indian Ocean and Adjacent Waters.

Recent data of some parameters of the carbon dioxide system in the Red Sea are presented and discussed in relation to the distribution of nutrients, water budget and general circulation in the Red Sea. Special attention is focussed on the variation of distribution of these parameters from winter to summer, and on the two regimes of circulation in the straits of Bab-el-Mandab. This is based mainly on the measurements made on the Meteor in December 1964 and the new data collected during two recent cruises on the R/V. Maeio-Dufresne in June and October 1982.
Index terms: biogeochemical cycle/seasonal variations/ocean circulation/ISW, Red Sea

51. Roberts, H.H., and S.P. Murray
Developing carbonate platforms: southern Gulf of Suez, northern Red Sea.
Marine Geology, vol. 59, p. 165-185, 1984.

The Ashrafi reef complex represents two small carbonate platforms and associated shoals located along the western side of the Jubal Strait. Active marine environment operating with the geological constraints of a tectonic trough characterized by mountainous fault-controlled margins. Origin of the platforms is uncertain, but the present morphology appears to be a product of the dynamic marine setting in which they are developing. Tidal flow between the Red Sea and the Gulf results in strong rectilinear currents. Side-scan sonar data, coupled with echo-sounder profiles, direct observations via Scuba, and bottom sampling inidcated that the Ashrafi platforms are actively building northward by windward reef accretion and extending to the south by sediment transport and accumulation.
Index terms: Red Sea/Egypt/sedimentation/oceanography/reefs/ geophysical surveys/acoustical surveys/processes/marine

52. Ross, D.A.
The Black Sea and the Sea of Azov.
Nairn, A. E. M.; Kanes, W. H.; Stehli, F. G., editors.
The ocean basins and margins.
New York, N.Y., : Plenum Press, 1977.
vol. 4A: The Eastern Mediterranean, p. 445-481,
(Woods Hole Oceanogr. Inst., Contrib. No. 3507)
Index terms: Black Sea/USSR/sedimentation/sediments / oceanography/ocean basins/geophysical surveys/surveys/rates/ provenance/lithostratigraphy/cores/Eurasia/East Mediterranean/

Mediterranean Sea/Azov Sea/ocean circulation/gravity anomalies/ magnetic anomalies/seismic surveys/gravity surveys/magnetic surveys/genesis

53. Seftor, J.L., and G.O. Roberts (Science Applications, Inc., McLean, VA,)
Sigma code testing. 1984.
NTIS Order No.: AD-A146 548/3/GAR

The SAI/NORDA Sigma Coordinate Ocean Foreasting computer code is a complicated simulation tool for modelling the behavior of the world's oceans. In this report, the authors present the result of a set of tasks which increase the code's accuracy and usefulness as a simulation tool. These tasks include the implementation of open boundary conditions, the creation of initialization data from mixed data sets, the improvement of output options, and the installation of the code on the VAX supermini computer. They also present the results of preliminary set up tasks for a simulation of the semiclosed basin of the eastern Mediterranean.
Index terms: computers/computer programs/prediction/ocean circulation/simulation/MED /SAI/NORDA

54. Shackleton, N.J.
Stable isotope stratigraphy of the eastern Mediterranean during the past 20,000 years; implications for sapropel formation, Gibraltar Straits current reversal, and heat budget of the glacial Atlantic.
The Geological Society of America, 92nd annual meeting. Geol. Soc. Am., Abstr. Programs. 1979, vol. 11, 514 p.
Index terms: Atlantic Ocean/Mediterranean Sea/isotopes/ foraminifera/paleoecology/paleoclimatology/organic materials/ carbon/oxygen /oceanography/ocean circulation/stratigraphy/ Quaternary/ratios/stable isotopes/biochemistry/genesis/sapropel/ C-13/C-12/O-18/O-16/East Mediterranean/Strait of Gibraltar/North Atlantic/North Atlantic Bottom Water/paleocirculation/paleo-oceanography/temperature/Cenozoic/upper Quaternary/planktonic taxa/benthonic taxa/marine environment/currents/reversals/heat budget/cores

55. Shemesh, A.; B. Luz; J. Erez and H. Steinitz
delta SUP 13 C, O SUB 2 in the carbonate system in the Gulf of Elat. ECOG 7; European colloquium of geochronology, cosmochronology and isotope geology. Israel Acad. Sci. and Humanities, Israel,

1981. p. 1
Index terms: carbon/isotopes/Red Sea/sea water /C-13/C-12/ geochemistry/Gulf of Aqaba/Indian Ocean/stable isotopes/ oxygen/ equilibrium/atmosphere/oxidation/organic materials/temperature/ dissolved materials/alkalinity/chemical composition/ photosynthesis/mixing/ocean circulation

56. Siedler, G.
General circulation of water masses in the Red Sea.
Degens, Egon T.; Ross, David A., editors.
Hot brines and recent heavy metal deposits in the Red Sea: a geochemical and geophysical account.
New York : Springer-Verlag, 1969. p. 131-137,
Rockville: 525.8.D317

A summary is given of the main features of the Red Sea circulation caused by evaporation and wind stress. Average temperature and salinity distributions are discussed, and some estimates of the water budget and water renewal times are calculated.
Index terms: currents (water)/salinity/density currents/ evaporation/water temperature/winds/oceanography/mapping/ climates/arid lands/Red Sea

57. Tomczak, M.Jr (Div. Fish. Oceanogr., CSIRO, Cronulla, Australia)
Regional oceanography of African waters.
LECTURES PRESENTED AT THE SIXTH FAO/SIDA WORKSHOP ON AQUATICPOLLUTION IN RELATION TO PROTECTION OF LIVING RESOURCES. SCIENTIFIC AND ADMINISTRATIVE BASIS FOR MANAGEMENT MEASURES.
NAIROBI AND MOMBASA, KENYA, 12 JUNE - 22 JULY 1978, p. 1-18, 1979.

The impacts of the oceanic circulations and water mass distributions, especially in relation to the east-west differences, of the special conditions in the Red Sea and of the major estuaries are discussed in order to gain an overview of the oceanography of African waters.
Index terms: ocean circulation/water masses/physical oceanography /Africa Coasts/ISW, Red Sea

58. Tziperman, Eli, and Artur Hecht (Dept. of Earth, Atmos., and Planetary Sci., MIT, Cambridge; Israel Ocean. and Limnological

Res., Tel Shikmona, Haifa, Israel)
Circulation in the eastern Levantine Basin determined by inverse methods.
Journal of Physical Oceanography, Boston, vol. 18, no. 3, p. 506-518, March 1988.

A finite-difference linear inverse model is applied to hydrographic data from six summer and fall cruises in a small area (250 MULTIPLIED BY 200 km) of the eastern Mediterranean Sea. The temperature and salinity equations are used to form a linear set of equations for the reference geostrophic velocities and the mixing coefficients, which are then solved by singular value decomposition. Advection by the horizontal velocities is the dominant process affecting the temperature and salinity fields in the region, and the model successfully resolves the horizontal velocities. Mixing and vertical advection are smaller by an order of magnitude, and the model cannot fully resolve the mixing coefficients and vertical velocities. The six velocity fields calculated from the data indicate a very strong variability that makes it difficult to identify a repeating summer or fall circulation pattern on the scale of the region covered by the data. An appendix contains the details of a new procedure for including linear inequalities in the solution of a rank-deficient system of linear equations.
Index terms: Oceanic circulation calculations/Eastern Mediterranean

59. Venkatarathnam, K., and W.B.F. Ryan (Lamont-Doherty Geological Observatory, Palisades, NY.)
Dispersal patterns of clay minerals in the sediments of the eastern Mediterranean Sea.
Marine Geology, vol. 11, no. 4, p. 261-282, Nov. 1971.

Six mineral assemblages have distinctive sources and their dispersal reflects different agents of transport in the eastern Mediterranean Sea. A Nile assemblage with large amounts of well-crystalized smectite (over 50%) and 15-25% kaolinite is found on the eastern Nile Cone and with the Eastern Levantine Basin. Its distribution results from dispersal by easterly currents which form part of the counter-clockwise gyre in the eastern Mediterranean. A southeast Aegean assemblage transported by Levantine intermediate water is characterized by 40-60% well crystalized smectite and higher contents of chlorite and illite than in the Nile assemblage. A kaolinite-rich assemblage (20-30% kaolinite), coinciding with high carbonate values, occurs on the

western section of the Mediterranean Ridge and in the western Nile Cone, as a consequence of transport by wind from North Africa. The restriction of Kithira and Messina assemblages (illite- and chlorite-rich assemblages) to deep parts of the Ionian Basin is chiefly due to water movements involved in deep circulation. A Sicilian assemblage with 20-30% kaolinite and 30-50% smectite in the westernmost part of the Ionian Basin south of Sicily is caused by dispersal by easterly moving surface waters.
Index terms: clay minerals/clays/distribution patterns/ provenance/ocean currents/sediment transport/streamflow/ocean circulation/deposition (sediments)/bottom sediments/suspended load/Mediterranean

60. Wang, Dong-Ping (Mar. Sci. Res. Cent., State Univ. New York, Stony Brook, NY)
The strait surface outflow.
J. GEOPHYS. RES. (C OCEANS), vol. 92, no. C10, p. 10807-10825, 1987.

A three-dimensional, primitive equation model is used to simulate the flow through a narrow strait. The flow within a strait has a simple two-layered structure with the interface located approximately at the middepth. However, the flow experiences a sharp transition at the strait's exit: the flow jumps from a subcritical velocity inside the strait to a supercritical velocity immediately outside the strait. Correspondingly, the density interface also slopes sharply upward to the surface. Model results compare well with observations in the Tiran Strait and in the Gibraltar Strait and Alboran Sea. The model study indicates that the flow transition at the strait's exit and the formation of an anticyclonic gyre are unique features of the nonlinear self-advection of the density current.
Index terms: MED, Gibraltar Strait/ISW, Red Sea, Tiran Strait/ nearshore dynamics/ ocean circulation/surface currents/channel flow/mathematical models/ straits/water exchange

IV. Oil and Marine Pollution

1. Abu, Gideiri Yousif B. (Saudi-Sudanese Jt. Red Sea Comm.; Jeddah; Saudi Arabia)
Impacts of mining on central Red Sea environment.
Deep-Sea Research, Part A, vol. 31, no. 6-8A, p. 823-8, 1984.
Index terms: seabed mining tailing Red Sea/marine environment tailing discharge/pollution prevention seawater tailing discharge /Mud, marine (metalliferous, mining of, tailing discharge environmental effects in, in Red Sea) /Mines and Mining (of metalliferous muds, environmental effects of tailings discharge in, in Red Sea) /Water pollution (prevention of, in tailing discharge from mining of metalliferous muds, in Red Sea)

2. Abu-Hilal, Ahmad H. (Marine Science Station, Aqaba, Jordan.)
Distribution of trace elements in nearshore surface sediments from the Jordan Gulf of Aqaba (Red Sea).
Marine Pollution Bulletin, vol. 18, no. 4, p. 190-3, 1987.
Index terms: heavy metal sediment pollution Jordan/metal gulf sediment pollution Jordan/sewage gulf sediment pollution Jordan /Geological sediments, Gulf (pollution of, by heavy metals, ship and boat activities and sewage discharge in relation to, of Gulf of Aqaba, Jordan)/Metals, heavy, biological studies (sediment pollution by, ship and boat activities and sewage discharges in relation to, of Gulf of Aqaba, Jordan)

3. Abu-Hilal, Ahmad H. (Mar. Sci. Stn.; Univ. Jordan; Aqaba; Jordan)
Fluoride distribution in the Jordan Gulf of Aqaba (Red Sea).
Sci. Total Environ., vol. 49, p. 227-34, 1986.
Index terms: fluoride distribution seawater Gulf Aqaba/phosphate rock sediment pollution fluoride/fluorapatite sediment pollution fluoride /Water pollution (by fluorides, phosphate rocks in relation to, of Gulf of Aqaba, Red Sea) /Organic matter (in sediment, phosphate rocks in relation to, of Gulf of Aqaba, Red Sea) /Geological sediments,gulf (pollution of, by fluoride, in Gulf of Aqaba, Red Sea) /Fluorides, biological studies (sediment and water pollution by, phosphate rock in relation to, of Gulf of Aqaba, Red Sea) /Phosphate rock and Phosphorite (sediment pollution by fluoride in relation to, in Gulf of Aqaba, Red Sea)

4. Abu-Hilal, Ahmad H., and Mohammed M. Badran
Effect of pollution sources on metal concentration in sediment cores

from the Gulf of Aqaba (Red Sea).
Marine Pollution Bulletin, vol. 21, no. 4, p. 190-?, Apr. 1990.
Index terms: pollution source effect/trace element/Red Sea (Gulf of Aqaba)/metal concentration/sediment core

5. AL-GHADBAN, A.N.; F. KHALAF; P. LITHERATHY, and D. AL-BAKRI
Total organic carbon in Kuwait's bottom sediments.
Annual research report-Kuwait Institute for Scientific Research, 1981.
Index terms: Marine sediments/Organic carbon/Granulometry/Pollution/ Marine environment/Persian Gulf/Kuwait

6. AL-HASHIMI, A.H., and H.H. SALMAN (Basrah Univ., Biology Dep., Iraq)
Trace metals in the sediments of the north-western coast of the Arabian Gulf.
Marine Pollution Bulletin, vol. 16, 1985.
Index terms: Soil pollution/Sediments/Metal/Trace element/Coastal zone/Persian Gulf

7. AL-RABEH, A.H.; H.M. CEKIRGE, and N. GUNAY (King Fahd Univ. Petroleum Minerals, Water Resources Environment Division, Dhahram, Saudi Arabia)
A stochastic simulation model of oil spill fate and transport.
Applied Mathematical Modelling, vol. 13, 1989.
Index terms: Water pollution/Spill/Oil layer/Advection/Turbulent diffusion/Dispersion/Emulsification/Evaporation/Algorithm/Stochastic model/Persian Gulf

8. Al-Saadi, H.A., and R.A.M. Hadi.
Ecological and taxonomical studies on phytoplanktons in Arab Gulf.
J. Sci. Ind. Res., Sect. C: Biol. Sci. (India), vol. 18, no. 3, Sep 1987.

The Arab Gulf is a semi closed sea, shallow in all its regions and important in carbonate, precipitation. Its water has the highest temperature in the world. Its salinity ranges 37-40% and effected by a diurnal tide. Light is to be not considered as a limiting factor for the primary productivity of the phytoplankton. It has a high content of dissolved oxygen and mostly reaching saturation condition. The pH is in alkaline (>8). The phytoplankton nutrients, namely nitrates, phosphates and silicates are present in higher concentrations in the north-west region than in waters near Kuwait, Qatar and United Arab Emirates. Chlorophyll-a content ranges between 0.2-13, 87 mg m/sup -3/. The primary productivity of the phytoplankton in the Gulf is

higher than in the Arabian sea or the Indian Ocean. There are 527 species recorded in the Gulf dominated by diatoms (79%) followed by dinoflagellates (13%). The Arab Gulf and the Arabian and Red sea are considered within the Basic Indo-Oceanic Complex. The study includes some recommendations for further studies on ecological and taxonomical parameters in the Arab Gulf.
Index terms: NITRATES -- ECOLOGICAL CONCENTRATION/PERSIAN GULF -- WATER POLLUTION/PHOSPHATES--PHYTOPLANKTON -PRODUCTIVITY/SILICATES --ECOLOGICAL CONCENTRATION/DIATOMS/ECOLOGY/PH VALUE/RECOMMENDATIONS/SPECIES DIVERSITY/ TAXONOMY /ALGAE/AQUATIC ORGANISMS/ARABIAN SEA/BIOLOGY/INDIAN OCEAN/NITROGEN COMPOUNDS/OXYGEN COMPOUNDS/PHOSPHORUS COMPOUNDS/ PLANKTON/PLANTS/POLLUTION/SEAS/SILICON

9. Al-Saad, Hamit T. (Mar. Sci. Cent.; Basrah Univ.; Basrah; Iraq)
Distribution of polycyclic aromatic hydrocarbons (PAH) in surficial sediments from Shatt Al-Arab River and the north-west region of the Arabian (Persian) Gulf.
Marine Pollution Bulletin, vol. 18, no. 5, p. 248-50, 1987.
Index terms: polyarom hydrocarbon sediment Persian Gulf/arom hydrocarbon sediment Persian Gulf/river sediment polyarom hydrocarbon Iraq /Water pollution (by petroleum, polycyclic arom. hydrocarbons in sediment in relation to, in Shatt Al-Arab River and northwestern Persian Gulf, Iraq) /Geological sediments, marine (pollution of, by polycyclic arom. hydrocarbons, in northwestern Persian Gulf) /Geological sediments,river (pollution of, by polycyclic arom. hydrocarbons, of Shatt Al-Arab River, Iraq) /Aromatic hydrocarbons,polycyclic,biological studies (sediment pollution by, petroleum pollution in relation to, in Shatt Al-Arab River and northwestern Persian Gulf, Iraq) /Petroleum (water pollution by, polycyclicd arom. hydrocarbons in sediment in relation to, in Shatt Al-Arab River and northwestern Persian Gulf)

10. Al-Shatti, I.; Al-Homoud, A.; Hamdan, L.S.; Hamdan, I., and Abdel-Jawad, M.M. (Coll. Technol. Stud., Kuwait)
Towards the use of industrial wastewater for irrigation in Kuwait.(eds.)
In the **PROCEEDINGS OF THE KUWAIT SYMPOSIUM ON MANAGEMENT AND TECHNOLOGY OF WATER RESOURCES IN ARID ZONES.** 1989. p. 115-124.

This paper focuses on the industrial wastewater discharged into the Gulf in the Shuaiba Industrial Area (SIA). The disposal of waste from vital industrial activities is causing coastal pollution threatening

the environment, and the supply to desalination plants. The shortage of irrigation water has led to a search for methods of reusing desalinated water. The Kuwait Institute for Scientific Research (KISR) and the Shuaiba Area Authority (SAA) have made a joint research study to protect marine ecology from industrial pollutants. Among their recommendations was the alternative of using such water for irrigation. The quality of the water, as indicated, presents no obstacles. However the duration and the quantity of flows were not discussed. This paper discusses the possibility of adding such a source to the allocated amounts for irrigation, based on time series analysis of the quantities of industrial wastewater delivered from Shuaiba Refinery (SR). The paper also suggests future work to capture the amounts of water releases below the industry.
Index terms: industrial wastes/pollution control/marine pollution/ pollution effects/wastewater treatment/desalination plants/Kuwait, Shuaiba/Persian Gulf

11. Aldhous, Peter.
Oil-well climate catastrophe? (Persian Gulf war).
Nature, Jan 10, 1991, vol. 349, no. 6305, p. 96.

12. ALEEM, A.A. (Univ. Alexandria, Fac. Sci., Oceanogr. Dep., Alexandria, Egypt)
Case studies of recent environmental hazards in the Eastern Mediterranean and Red Sea.
Natural and man-made hazards. International symposium, p. 465-475, 1988.
Published by D. Reidel, Dordrecht, Netherlands.
Index terms: Pollution/Human activity/Marine environment/Biota/Fuel resources/Sewage/Salinity/Impact statements/Conservation/Urbanization/ Southern Europe/East Mediterranean/Egypt/Red Sea

13. ALEEM, A.A. (OCEANOG. DEP., FAC. SCI., KING ABDULAZIZ UNIV., JEDDAH, SAUDI ARABIA)
SEAGRASS ALONG THE RED SEA COAST OF SAUDI-ARABIA.
AQUAT. BOT., 1979, p. 71-78.

The distribution and ecology of marine phanerogams were recorded along a distance of 270 km of the Saudi Red Sea Coast, including Jeddah and Sharm Obhor. The seagrasses occur in pure patches or in communities with 1 or more dominant species. Some, like S. isoetifolium (Aschers.) Dandy, thrive well in clear circulating water, while others such as C. rotundata Ehr. et Hemprich, T. hemprichii (Ehr.) Aschers. and H. uninervis (Forsk.) Aschers. can withstand pollution. All 9 spp. of

seagrasses [Thalassodendron ciliatum, Cymodocea rotundata, C. serrulata, Halodule uninervis, H. stipulacea, H. ovata, Thalassia hemprichii, Syringodium isoetifolium and Enhalus acoroides] previously known in the Red Sea were collected. The following taxa are new records to the Saudi Coast of the Red Sea: C. rotundata, S. isoetifolium, H. stipulacea (Forsk.) Aschers. and H. ovata Gaudichaud. The latter may be considered as a new addition to the Red Sea flora.
Index terms:
THALASSODENDRON-CILIATUM/CYMODOCEA-ROTUNDATA/CYMODOCEA-RRSEULATA/HALODULE-UNINERVIS/HALODULE-STIPULACEA/HALODULE-A/OVATTHALASSIA-HEMPRICHII/SYRINGODIUM-ISOETIFOLIUM/ENHALUS-ACOROIDES/ECOLOGY/DISTRIBUTION/POLLUTION/TOLERANCE

14. Ali, M.Y., and J.P. Riley (Environ. Prot. Dep., Minist. Public Heath, Kuwait)
The distribution of halomethanes in the coastal waters of Kuwait.
MAR. POLLUT. BULL., 1986, p. 409-414.

Chlorination of sea water used as cooling and feed water in the combined desalination-power plants of Kuwait leads to the formation of appreciable quantities of halomethanes. Significant concentrations of these compounds (up to 90 mu g l super(-1) as total haloforms) are present in the sea in the immediate vicinity of the out-falls from these plants. Beyond the point of discharge, the distributions of these compounds are consistent with the hydrography of the area, concentrations falling to below the detection limit (0.1 mu g l super(-1)) within a few kilometres as a result of mixing and evaporation. Bromoform generally accounts for 95% of the total halomethanes, almost all of the remainder being dibromochloromethane.
Index terms: halomethanes/Kuwait/Persian Gulf/marine pollution/chemical pollutants/coastal water/bromoform/dibromochloromethane

15. Anderlini, Victor C.; Omar S. Mohammed; Mazin A. Zarba; Scott W. Fowler, and Pierre Miramand (Environmental Sciences Dept., Kuwait Inst. for Scientific Res., Kuwait; Intl. Lab. of Marine Radioactivity, IAEA, Musee Oceanographique, Monaco.)
Trace metals in marine sediments of Kuwait.
Bulletin of Environmental Contamination and Toxicology, vol. 28, p. 75-80, 1982.

This report presents the results of analyses for ten trace metals (Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, V and Zn) in marine surface sediments from Kuwait and discusses the grain size and total organic content on the

observed concentrations of these metals.

16. Anon
Distribution of Cd, Cr, Cu, and Zn in Eastern Mediterranean Fishes.
Marine Poll. Bull., 1987, p. 45-49.

The present work was undertaken to determine ranges and natural variations of some important trace metals in fishes of economic importance to the Eastern Mediterranean. Specimens were collected by deep trawl at 17-44 fathom depth at five locations along the coast of Israel. All sample preparation in the field and the laboratory followed the procedures of Bernhard (1976). Four common species, Mullus barbatus, Upeneus moluccensis, Saurida undosquamis and Pagellus erythrinus, were selected for more detailed study. Qualtatively the ranges of all metals are similar in these four species.
Index terms: cadmium/chromium/copper/zinc/Mediterranean Sea/heavy metals/marine pollution

17. Anon.
The management and conservation of renewable marine resources in the Indian Ocean region II KAP Region.
1985. Unpublished report.

18. Anon.
Saudi Arabia: the Nowruz oil spill.
Sirenews, p. 12-13, April 1984.

19. Apple, R. W., Jr.
Relentless tide of oil fouls shores of empty Saudi city. (Khafji, Saudi Arabia; oil spill in Persian Gulf).
New York Times, Jan 28, 1991, v140 col 3, pA1(N) pA1(L).

20. **ARAMCO UNIT'S TEXAS OFFICE SWAMPED WITH CALLS ABOUT OIL SPILL IN GULF.**
United Press International, Feb 1, 1991,

21. Arnone, R.A.; J.A. Galt; R.M. Partridge, and R.L. Pickett
The Persian Gulf, oil and natural circulation.
Sea Technology, vol. 25, no. 9, p. 23-?, Sept. 1984.
Index terms: circulation pattern/Persian Gulf/Saudi Arabia/oil spill movement/remote sensing

22. Asanuma, I.; K. Muneyama; Y. Sasaki; J. Iisaka, and Y. Yasuda (Japan Marine Science and Technology Center, Yokosuka; Canada Centre

for Remote Sensing, Ottawa; Chiba Univ., Japan)
Satellite thermal observation of oil slicks on the Persian Gulf.
Remote Sensing Environ. (United States), vol. 19, Apr 1986.

A possibility of oil slicks detection is discussed for oil slicks spread in the vicinity of the Nowruz oil fields in the Persian Gulf since March 1983 to July 1983 with considering an apparent thermal inertia. The apparent thermal was computed from continuous observations of sea surface temperature and albedo by the Advanced Very High Resolution Radiometer (AVHRR) on the NOAA-7 through day and night with 12 h interval. The apparent thermal inertia is defined as a function of a temperature difference between the daytime and the nighttime and an apparent albedo. Sea surface temperature used for computing the apparent thermal inertia was obtained through an atmospheric correction with an empirical equation which uses an energy difference between two thermal channels of the AVHRR. Although there was an ambiguity on a selection of same object on water body, the computed apparent thermal inertia showed the possibility of oil slicks detection from sea water. 17 references.
Index terms: OIL SPILLS -- DETECTION/PERSIAN GULF -- OIL SPILLS / ALBEDO/MONITORING/SATELLITES/TEMPERATURE MEASUREMENT/WATER POLLUTION/ARABIAN SEA/INDIAN OCEAN/POLLUTION/SEAS/SURFACE WATERS

23. Atkinson, Rick; Hoffman, David
U.S. jets bomb Kuwaiti pipeline to cut oil flow; General hopeful torrent into Gulf has been reduced. (U.S. tries to stop massive oil spill in Persian Gulf)
Washington Post, Jan 28, 1991, v114 col 6, pA1.

24. **AUSTRALIAN OIL SPILL EQUIPMENT TO BE USED IN GULF CLEANUP.**
PR Newswire, Feb 7, 1991.

25. AWAD, H. (DEP. MAR. CHEM., FAC. MAR. SCI., UNIV. KING ABDULAZIZ, 21441 JEDDAH, SAUDI ARABIA)
AROMATIC HYDROCARBONS IN SOME ORGANISMS OF COASTAL RED SEA.

INDIAN J MAR SCI, 1987, p. 114-116.

Thirty samples of marine organisms (algae, molluscs and fish) were collected and the total aromatic hydrocarbon content, as an indicator of oil contamination, in each sample was analysed using high performance liquid chromatography. The concentration of the aromatic fraction in different samples varied from 1 to 7% of the corresponding

total hydrocarbon content depending on the species and the locality of its occurrence. The composition of the aromatic fraction in all samples was primarily bi- and tricyclic compounds.
Index terms: ALGAE/MOLLUSK/FISH/OIL/CONTAMINATION/POLLUTION/BIOINDICATOR

26. Awad, Hassan (Dep. Oceanogr.; Fac. Sci. Moharram Bek; Alexandria; Egypt)
Oil contamination in the Red Sea environment.
Water, Air, Soil Pollut., vol. 45, no. 3-5, p. 235-42, 1989.
Index terms: pollution seawater oil Red Sea/petroleum spill Red Sea pollution /Water pollution (by oily wastewater discharges, of seawater, survey of, in Red Sea) /Petroleum refining/Petroleum wells (discharges from, survey of, water pollution in relation to, in Red Sea) /Petroleum recovery (offshore and onshore, discharges from, survey of, water pollution in relation to, in Red Sea) /Waters, ocean (oil spills on, survey of, in Red Sea) /Petroleum products, oil spills/Petroleum, oil spills (on seawater, survey of, in Red Sea)

27. Awad, Hassan (Fac. Marine Sci.; King Abdulaziz Univ.; Jeddah; Saudi Arabia)
Oil in Saudian Red Sea territorial waters.
Marine Pollution Bulletin, vol. 19, no. 6, p. 287-90, 1988.
Index terms: oil pollution Red Sea /Water pollution (by petroleum, in Saudi Red Sea) /Petroleum,oil spills (water pollution by, in Saudi Red Sea)

28. Awad, Hassan (Fac. Mar. Sci.; King Abdulaziz Univ.; Jeddah; Saudi Arabia)
Role of Petromin refinery in adding crude oils to Jeddah coastal waters, Saudi Arabia.
J. Fac. Mar. Sci. (King Abdulaziz Univ.), vol. 4, p. 131-44, 1985.
Index terms: seawater pollution petroleum refinery Jeddah /Water pollution (by petroleum, of coastal waters, from refining operations, of Red Sea, at Jeddah, Saudi Arabia) /Petroleum (seawater pollution by, in wastewater from refinery, of Saudi Arabia) /Petroleum refining (wastewaters from, crude oils in, coastal water pollution by, of Red Sea, at Jeddah, Saudi Arabia)

29. Aydogdu, Turkan; Turgutl. Balkas; Ferit Bingel; Ilkay Salihoglu, and Suleyman Tugrul (Inst. Mar. Sci.; Middle East Tech. Univ.; Icel; Turkey)
Mercury in some fish of the North Levantine (eastern Mediterranean) Sea.

Journ. Etud. Pollut. Mar. Mediterr., 6th.
Monaco, Monaco:Comm. Int. Explor. Sci. Mer Mediterr., 1983. p. 261- 9.
Index terms: mercury fish organ water pollution/Upeneus organ mercury sea pollution/Saurida org mercury sea pollution/Mullus organ Mercury sea pollution /Water pollution (by mercury-contg. fungicides, mercury of sea fish organs in relation to) /Digestive tract/Gill/Head/ Heart,composition/Liver,composition/Muscle,composition/Organ/ Reproductive tract/Scale(anatomical)/Skin,composition/Spinal column/ Muscle,composition (mercury of, of sea fish, seawater pollution with mercury-contg. fungicides in relation to) /Fish/Mullus barbatus/ Saurida undosquamis/Upeneus mollucensis/Upeneus mollucensis (mercury of organs of, age and annual season effect on) /Development, nonmammalian/Rhythm,biological, annual/Rhythm,biological, annual (mercury of organs of sea fish response to, seawater pollution with mercury-contg. fungicides in relation to) /Fungicides and Fungistats/ Fungicides and Fungistats

30. Baker, J.M.
Impact of oil pollution on living resources.
Gland, Switzerland : IUCN, 1983.
(Commission on Ecology papers ; no. 4)

31. Ballestra, S.; M. Thein, and R. Fukai (Int. Lab. Mar. Radioact.; IAEA; Monaco)
Particulate transuranic elements in the eastern Mediterranean Sea.
Journ. Etud. Pollut. Mar. Mediterr., 5th.
Monaco : Comm. Int. Explor. Sci. Mer Mediterr., 1981. p. 991-5.
Index terms: actinide seawater particulate pollution Mediterranean/ plutonium seawater particulate pollution Mediterranean/americium seawater particulate pollution Mediterranean /Particles/Suspensions, marine (americium and plutonium in, in waters of eastern Mediterranean Sea) /Water pollution (by americium and plutonium, in eastern Mediterranean Sea)

32. Banta, Kenneth W.
A glut that is all too visible. (Persian Gulf oil slick).
Time, April 18, 1983, v121, p51(1).

33. Basson, P.W. ... et al.
Biotopes of the Western Arabian Gulf.
Dhahran, Saudi Arabia : Aramco Dept. of Loss Prevention and Environmental Affairs, 1977.

34. Basturk, Ozden; Mahmut Dogan; Ilkay Salihoglu, and Turgutl. Balkas (Mar. Sci. Dep.; METU; Icel; Turkey)

DDT, DDE, and PCB residues in fish, crustaceans and sediments from the Eastern Mediterranean coast of Turkey.
Mar. Pollut. Bull., vol. 11, no. 7, p. 191-5, 1980.
Index terms: organochlorine pesticide fish sediment Turkey/PCB pesticide fish sediment Turkey /Water pollution (from organochlorine pesticides and PCB, in fish and sediments, in Turkey) /Pesticides (organochlorine, in crustaceans and fish and sediments from Eastern Mediterranean Coast of Turkey) /Geological sediments/Mugil auratus/ Mullus barbatus/Mullus surmuletus/Panaeus kerathurus/Patella coerulea/Upeneus mollucensis (organochlorine pesticides and PCB residues in, from Eastern Mediterranean Coast of Turkey)

35. Becacos-Kontos, T., and R.C. Dugdale (Democritus Nuclear Research Center, Athens, Greece)
Pollution in Greek waters.
Marine Pollution Bulletin, vol. 2, no. 10, p. 158-160, Oct. 1971.

The effect of sewage outfall on eutrophication in the Eastern Mediterranean is studied. The report of the co-operative Greek-American investigation includes a discussion of a mapping survey and objectives for the continued investigation under the international biological programme. The project centered at Democritus and the University of Washington. "Dynamics of Biological Production in Upwelling Ecosystems" will include development of simulation models, kinetics of nutrient uptake and wind driven current studies. Prediction of chlorophyll distribution when given the input of wind, incoming radiation, nutrient concentration and sewage effluents will be emphasized.
Index terms: eutrophication/sewage effluents/outlets/surveys/ productivity/mapping/upwelling/ecosystems/nutrients/simulation analysis/kinetics/currents/chlorophyll/distribution patterns/Greece/ Eastern Mediterranean/Democritus

36. Begley, Sharon
Death of the Persian Gulf.
Newsweek, July 25, 1983, v102, p79(1).

37. Begley, Sharon
Saddam's ecoterror; the Iraqi oil flood creates environmental hazards and military obstacles. (The War: Desert Storm)(includes related article on air pollution hazards).
Newsweek, Feb 4, 1991, v117 n5, p36(4).

38. Behairy, A.K. A., and M.M. El-Sayed (Fac. Mar. Sci.; King

Abdulaziz Univ.; Jeddah; Saudi Arabia)
Dissolved organic matter in coastal waters at Jeddah, Saudi Arabia.
Marine Pollution Bulletin, vol. 15, no. 3, p. 113-16, March 1984.

Water samples collected during April 1982-April 1983 from Red Sea coastal waters at Jeddah, Saudi Arabia, were investigated for dissolved organic carbon, dissolved organic nitrogen, dissolved lipid, dissolved organic phosphorous, dissolved monosacchardies, total dissolved sugars and dissolved polysaccharides. The variations in the observed dissolved matter distribution pattern are caused by its release by phytoplankton in the various stages of its growth, release from detrital materials and its pouring from exogenous sources like domestic wastes or other types of pollutants, and their utilization by heterotrophic organisms. Extremely high DOC values at two stations can be attributed to the direct effect of untreated wastes at those two locations. Since the consumption of oxygen is intimately linked to the oxidation of organic matter, in the presence of high concentrations of organic matter the consumption rate of oxygen will exceed that of its supply, leading to a reducing condition which favors the accumulation of excess organic matter.
Index terms: org matter seawater Saudi Arabia /Carbohydrates and Sugars,biological studies/Lipids,biological studies/ Monosaccharides/ Polysaccharides, occurrence (dissolved, in coastal waters of Red Sea, at Jeddah, Saudi Arabia) /Organic matter, dissolved (water pollution by, of coastal areas of Red Sea, at Jeddah, Saudi Arabia)

39. Behairy, A.K. A.; O.A. El-Rayis, and A.M. Ibrahim (Fac. Mar. Sci.; King Abdulaziz Univ.; Jeddah; Saudi Arabia)
Preliminary investigations of some heavy metals in water, sediments and plankton in Obhur Creek (eastern Red Sea).
J. Fac. Mar. Sci. (King Abdulaziz Univ.), vol. 3, p. 129-39, 1983.
Index terms: heavy metal stream Saudi Arabia/sediment metal stream Saudi Arabia/phytoplankton metal stream Saudi Arabia /Geological sediments,stream/Plankton, phyto- (heavy metals in, pollution in relation to, of Obhur creek, Jeddah, Saudi Arabia) /Waters, natural, stream (heavy metals in, pollution in relation to, of Obhur Creek near Jeddah, Saudi Arabia) /Metals,heavy, occurrence (in stream waters and sediments and plankton, of Obhur Creek near Jeddah, Saudi Arabia)

40. Behairy, A.K. A., and A.M. M. Ibrahim (Mar. Sci. Inst.; King Abdulaziz Univ.; Jeddah; Saudi Arabia)
Sublethal effects of heavy metals on Nitzschia closterium from the Red Sea.
Jeddah J. Mar. Res., vol. 1, p. 65-9, 1981.

Index terms: trace element metal Nitzschia/heavy metal toxicity Nitzschia/water pollution heavy metal Nitzschia /Water pollution (by heavy metals, Nitzschia closterium of Red Sea responses in relation to) /Nitzschia closterium (heavy metal toxicity to, of Red Sea) / Toxicity (of heavy metals, to Nitzschia closterium, of Red Sea) /Trace elements,metals, heavy

41. Behairy, A.K. A., and M.A. H Saad (Fac. Mar. Sci., King Abdulaziz Univ., Jeddah, Saudi Arabia)
Effect of pollution on the coastal waters of the Red Sea in front of Jeddah, Saudi Arabia. 2. Nutrient salts.
TETHYS, 1984, p. 119-125.

The seasonal variations in the average values of each nutrient at stations near the waste disposal are principally related to variations in the discharge rate of sewage wastes. However, the seasonal variations at locations relatively further away from pollution sources are mainly attributed to the different conditions responsible for increasing or decreasing the nutrient content in the different seasons. The remarkably high average value of each nutrient calculated for the study area during the investigation period is due to the effect of pollution and the limited exhange between the waters of the study area and the open sea.
Index terms: seasonal variations/salts/marine pollution/coastal water

42. Behairy, A.K. A., and M.A. H Saad (Fac. Mar. Sci., King Abdulaziz Univ., Jeddah, Saudi Arabia)
Effect of pollution on the coastal waters of the Red Sea in front of Jeddah Saudi Arabia. 1. Environmental conditions.
TETHYS, 1984, p. 111-117.

Variations of some environmental conditions in the coastal Red sea waters in front of Jeddah, which continuously receive untreated domestic wastes, were studied. The slight decrease in the bottom water temperatures coincided with the shallowness of the study area. Dissolved oxygen (DO) waste disposal, due to the anaerobic bacterial decomposition of the accumulated decayed organic wastes. The highest regional average DO values were found at locations relatively further away from pollution sources, where the photosynthetic activity has increased as indicated by the highest regional average Secchi values.
Index terms: marine pollution/coastal water/DO/waste disposal/Red Sea

43. BEN-ELIAHU, M.N., and J. DAFNI (DEP. OF ZOOL., HEBREW UNIV. OF JERUSALEM, JERUSALEM, ISRAEL)

FILOGRANELLA-ELATENSIS NEW-GENUS NEW-SPECIES OF REEF BUILDING SERPULID FROM THE GULF OF ELAT AND THE RED SEA WITH NOTES ON OTHER GREGARIOUS TUBEWORMS FROM ISRAELI WATERS.
ISR J ZOOL, 1979, p. 199-208.

HILOGRANELLA elatensis, gen. et sp. nov. built a serpulid reef within a crevice of a coral knoll near Elat port, Gulf of Elat (= Gulf of Aqaba). The knoll is in a shallow area subject to thermal and chemical pollution. The species and its habitat are described. Previously undescribed material from the Red Sea coast of Saudi Arabia is referred to this species. Some other gregarious species of Serpulidae in Israeli waters are considered.
Index terms: THERMAL POLLUTION/CHEMICAL POLLUTION/SAUDI-ARABIA

44. Ben-Yami, M., and T. Glaser (Fisheries Technology Unit, Haifa, Israel)
The invasion of Saurida undosquamis (Richardson) into the Levant Basin: an example of biological effect of interoceanic canals.
U.S. National Marine Fisheries Service Bulletin, vol. 72, no. 2, p. 359-373, 1974.

The Red Sea lizardfish, S. undosquamis, invaded the Levant Basin (Red Sea-Mediterranean Sea) and established a population of considerable commercial importance. Its expansion came at the expense of other commercial fishes on which it preys and with which it competes. The rapid reproduction of the Red Sea lizardfish population in the Levant Basin was made possible by a combination of changes in the environmental conditions (abiotic and biotic), one of these being the retreat of, or the recession in, the native hake population. The dynamic coexistence between the lizardfish and the hake, its main competitor, is affected by fluctations in the abiotic conditions to which the hake seems to be more sensitive than the lizardfish.
Index terms: canals/hake/interoceanic canals/Red Sea lizard fish/ abiotic conditions/Levant/Saurida undosquamis/water pollution effects/ Levant Basin (Red Sea-Mediterranean Sea)

45. Benzhitskiy, O.G.
Quantitative distribution of oil units and polymer materials in the Mediterranean, Red Sea and Atlantic Ocean.
Visn. Akad. Nauk Ukr. RSR (Ukrainian SSR), vol. 8, 1983.

During the trip of the 22nd scientific research vessel "Akademik Vernadskiy" (1980) and the trip of the 11th scientific research

vessel "Professor Vodyanitskiy" (1980), a known technique was used to determine the content of oil aggregates and polymer materials on the water surface. In the Mediterranean Sea, the oil aggregates were recorded during the entire trip. The most contaminated water area was the African coast of the Mediterranean (5950 units per 1 km/sup 2/). The greatest contamination with polymer materials was noted in the Tunesian Gulf and the water area to the south of Greece (from 1815 to 5160 units per 1 km/sup 2/). The surface of the Red Sea was contaminated predominantly with oil aggregates. The maximum quantity was noted in the central part of the Red Sea up to 7877 units per 1 km/sup 2/. It is noted that the quantity of oil aggregates on the surface of the Red Sea as compared to 1978 is somewhat reduced. The surface of the South Atlantic along the African coast is less contaminated than that of seas of the Mediterranean Basin and the Red Sea. The quantity of oil aggregates and polymer materials there averages 324 and 140 units per 1 km/sup 2/. Decrease in contamination by oil aggregates of water areas of the Mediterranean and Red Seas, as well as the Atlantic Ocean are linked to decrease in the overflow of oil residues by the tanker fleet from 2133 thousand T in 1971 to 1503 thousand T in 1980.
Index terms: ATLANTIC OCEAN -- OIL SPILLS/ATLANTIC OCEAN -- QUANTITATIVE CHEMICAL ANALYSIS/ATLANTIC OCEAN -- SURFACE CONTAMINATION/ATLANTIC OCEAN -- WATER POLLUTION/MEDITERRANEAN SEA

46. BINGEL, F.; D. AVSAR, and M. UNSAL (Inst. Marine Sci., Erdemli-Icel, Turkey)
A note on plastic materials in trawl catches in the north-eastern Mediterranean.
Meeresforschung, vol. 31, 1987.
Index terms: Plastics/Water pollution/East Mediterranean/Marine environment

47. **Black rain blamed on Kuwait oil fires. (Iran) (The Gulf War)**
Los Angeles Times, Jan 24, 1991, v110 col 6, pA7.

48. **Black rain falls in Iran again.**
Japan Economic Newswire, Jan 27, 1991.

49. BLISS-GUEST, PATRICIAA., and STEPAN KECKES
THE REGIONAL SEAS PROGRAMME OF UNEP,.
ENV CONSERVATION, SPRING 1982, . vol. 9, no. 1, p. 43-49.

THE U.N. ENVIRONMENT PROGRAMME'S REGIONAL SEAS PROGRAMME CONSISTS OF RESEARCH, MANAGEMENT OF MARINE LIVING

RESOURCES, AND MARINE POLLUTION CONTROL. ACTION PLANS FORMULATED THROUGH REGIONAL LEGAL AGREEMENTS ARE PRESENT IN THE FOLLOWING AREAS: MEDITERRANEAN SEA, KUWAIT, CARIBBEAN, WEST AND CENTRAL AFRICA, EAST AFRICA, EAST ASIAN SEA, RED SEA, SOUTHWEST PACIFIC, SOUTHEAST PACIFIC, AND SOUTHWEST ATLANTIC.
Index terms: U N ENV PROGRAMME /MARINE RESOURCES MANAGEMENT /INTL ENV PROGRAMS/AREA COMPARISONS /COASTAL WATERS /MARINE POLLUTION CONTROL / MEDITERRANEAN SEA /MARINE POLL CONT CONFS /LAW, ENV-INTL / CARIBBEAN SEA

50. Bourne, W.R. P (Dep. Zool., Aberdeen Univ., Aberdeen, UK)
Oil and garbage in the (Persian) Gulf.
MAR. POLLUT. BULL, 1989, p. 90.

There has been a great deal of speculation whether the recent hostilities in the Persian Gulf were likely to have had an adverse effect on the unique natural environment, especially in view of the amount of oil that was thought to have been spilt there. While there was said to be some oil pollution of the upper Gulf, it was inconspicuous in its approaches, possibly because it disperses rapidly with the high temperatures there.
Index terms: oil pollution/domestic wastes/beaches/Persian Gulf/ surveys/marine pollution

51. Brining, D.L.; W.C. Lester; W.N. Jessee; D.A. O'Leary; S. Bourgeois, and M.S. A Salam (Lockheed Missiles and Space Co, Carlsbad, California)
Development of environmental standards for combined desalination/ power generating stations in the Arabian Gulf Region.
Desalination (Netherlands). International congress on desalination and water reuse, vol. 39, no. 1-3, p. 255-260, Dec 1981.

Environmental effects associated with desalination/power generation are classified into intake and discharge components. The intake component consists of entrainment and impingement problems while the discharge component comprises chemical and physical problems associated with the receiving waterbody. Each component is discussed relative to marine communities in the receiving waterbody and a methodology is presented for establishing an environmental management policy which will protect these communities.
Index terms: DESALINATION PLANTS -- ENVIRONMENTAL EFFECTS/PERSIAN GULF -- DESALINATION PLANTS/PERSIAN GULF -- THERMAL POWER PLANTS/THERMAL POWER PLANTS -- ENVIRONMENTAL EFFECTS /AQUATIC ECOSYSTEMS/ENTRAINMENT/ IMPINGEMENT/TOXIC MATERIALS/WASTE

WATER/WATER POLLUTION /ARABIAN SEA/ECOSYSTEMS/HYDROGEN COMPOUNDS/INDIAN OCEAN/INDUSTRIAL PLANTS/
LIQUID WASTES/MATERIALS/OXYGEN COMPOUNDS/ POLLUTION/POWER PLANTS/SEAS/ SURFACE WATERS/WASTES/WATER

52. **BRITISH WILDLIFE EXPERTS TO HELP SAUDI ARABIA COPE WITH OIL SPILL.**
United Press International, Feb 3, 1991.

53. Brown, R.A.; T.D. Searl; J.J. Elliott; P.H. Monaghan, and n.D. E. Brando (Exxon Research and Engineering Co., Linden, N.J. Analytical and Information Div. Maritime Administration, Washington, D.C.; Exxon Production Research Co., Houston, Texas)
Measurement and Interpretation of Nonvolatile Hydrocarbons in the Ocean. Part I. Measurements in Atlantic, Mediterranean, Gulf of Mexico, and Persian Gulf Rept. for Jun 72-Dec 73.
Jul 1974, 221 p.

Little quantitative data are available on the amount and composition of hydrocarbons in the sea. To obtain such data, water samples were taken from tankers along four main routes in the Atlantic and adjacent seas and in other locations from oceanographic research vessels. Floating oil or tar balls were not collected. The water samples were extracted with carbon tetrachloride. The amount of extractable organic material and the amount and composition of nonvolatile hydrocarbons were measured. Hydrocarbons (with a mean of 4 ppb) were log-normally distributed in the samples collected through the top 10 meters of the water column. In deeper ocean waters hydrocarbon content generally declined with depth, and the median value was less than 1 ppb. Based on relative amounts of hydrocarbons and of total CCL4 extractable material, it is estimated that the hydrocarbons are mostly petroleum-derived in locations where petroleum input into the sea is likely. Additional work is needed to confirm and extend these findings.
Index terms: Water analysis/Oceans/Hydrocarbons/Quantitative analysis/ Solvent extraction/Crude oil/Oil pollution/North Atlantic Ocean/ Mediterranean Sea/Mexico Gulf/Persian Gulf

54. BRUNER, F.; G. CRESCENTINI; F. MANGANI; E. BRANCALEONI; A. CAPPIELLO, and I.P. CICCIOL (INSTITUTO SCI. CHIMICHE, UNIV. URBINO, PIAZZA RINASCIMENTO, 6-61029 URBINO, ITALY)
DETERMINATION OF HALO CARBONS IN AIR BY GAS CHROMATOGRAPHY HIGH
RESOLUTION MASS SPECTROMETRY.

ANAL CHEM, 1981, p. 798-801.
Qualitative and quantitative analyses of air samples for halocarbons at the ppt [parts per trillion] level using high-resolution mass spectrometry in the selected ion monitoring mode and selective packed columns was described. Permeation tubes were used as primary standards. Some results obtained in the determination of CCl3F (F[Freon]-11) and CHCl2F (F-21) in air samples from Red Sea, Indian Ocean and Italian locations were reported.
Index terms: FREON-11/FREON-21/TRI CHLOROFLUORO METHANE/DI CHLOROFLUORO METHANE/AIR POLLUTION

55. Bryant, M.
The (Persian) Gulf: pollution and development.
Environmental Conservation, vol. 8, no. 1, p. 44-?, Spring 1981.
Index terms: Kuwait Action Plan/Persian Gulf/marine pollution/ petroleum industry (development)

56. Bryant, Margi
The fragile Persian Gulf.
World Press Review, March 1981, v28, p55(1).

57. BURKE, R.A. JR; J.M. BROOKS, and W.M. SACKETT (DEP. MARINE SCI., UNIV. SOUTH FLORIDA, 830 FIRST ST. SOUTH, ST. PETERSBURG, FL)
LIGHT HYDRO CARBONS IN RED SEA BRINES AND SEDIMENTS.
GEOCHIM COSMOCHIM ACTA, 1981, p. 627-634.

Light hydrocarbon (C1-C3) concentrations in the water from 4 Red Sea brine basins (Atlantis II, Suakin , Nereus and Valdivia Deeps) and in sediment pore water from 2 of these areas (Atlantis II and Suakin Deeps) were reported. Hydrocarbon gases in the Suakin Deep brine (T [temperature] = .apprx. 25.degree. C, Cl- = .apprx. 85%, CH4 = .apprx. 7 l/l) were apparently of biogenic origin as evidenced by C1/(C2 + C3) ratios of .apprx. 1000. Methane concentrations (6-8 .mu.l/l) in Suakin Deep sediments were nearly equal to those in the brine, suggesting sedimentary interstitial waters may be the source of the brine and associated methane. Atlantis II Deep had 2 brine layers with significantly different light hydrocarbon concentrations indicating separate sources. The upper brine (T = .apprx. 50.degree. C, Cl = .apprx. 73%, CH4 = .apprx. 155 .mu.l/l) gas was of biogenic origin [C1/(C2 + C3) = .apprx. 1100]. The lower brine (T = .apprx. 61.degree. C, Cl-= .apprx. 155.permill., CH4 = .apprx. 120 .mu.l/l) gas was of thermogenic origin [C1/(C2 = C3) = .apprx. 50]. The thermogenic gas resulting from thermal cracking of organic matter in the sedimentary column migrated into the basin with the brine. The biogenic gas was

produced in situ or at the seawater-brine interface. Methane concentrations in Atlantis II interstitial waters underlying the lower brine were about 1/2 brine concentrations; this difference possibly reflected the known temporal variations of hydrothermal activity in the basin.
Index terms: METHANE/WATER POLLUTION/SOIL POLLUTION/TEMPERATURE/

BIOGENIC/ORIGIN

58. Carp, E.
Directory of wetlands of international importance in the Western Palearctic.
Gland, Switzerland : UNEP/IUCN, 1980.

59. Cavari, B., and R.R. Colwell. (Israel Oceanogr. and Limnol. Res., Tel-Shikmona, Haifa, Israel)
Effect of pollution on the bacterial community structure in the coastal waters of the Eastern Mediterranean Sea.
Jones, E.B. G., and Miller, J.D. (editors)
1. Int. Symp. on the Microbial Ecology of the Mediterranean Sea (MEM I). ASPECTS OF MARINE MICROBIOLOGY.
OXFORD (UK) : PERGAMON PRESS, 1988. pp. 147-157.

Microorganisms, like all biological systems, respond to the biological and abiotic environment and, under stress, the structure of the microbial community changes. The utility of bacteria as indicators of environmental perturbations resulting from chronic or low-level input of allochthonous materials in an aquatic environment has not been investigated extensively. In view of their ubiquitous distribution, short generation time, and sensitivity to changes in the physical and chemical environment, bacteria may be the first component of the marine habitat to be affected by altered environmental conditions. The autochthonous bacterial community of aquatic systems may, therefore, provide a means of detecting environmental perturbations. This study characterizes bacterial community changes in the polluted coastal waters of the Eastern Mediterranean.
Index terms: bacteria/Mediterranean Sea/marine pollution/bioindicators

60. Cember, Richard (Lamont-Doherty Geol. Obs.; Columbia Univ.; Palisades; NY)
Bomb radiocarbon in the Red Sea: A medium-scale gas exchange experiment.
J. Geophys. Res., C: Oceans, vol. 94, no. C2, p. 2111-23, 1989.
Index terms: carbon dioxide flux Red Sea/atm carbon dioxide flux seawater/radiocar bon seawater tracer gas exchange /Water pollution

(by carbon-14, from nuclear test explosions, history of, in Red Sea and Gulf of Aden)/Atmosphere, troposphere (carbon dioxide exchange between seawater and, bomb-produced carbon-14 as tracer of, of Red Sea and Gulf of Aden)/Waters, ocean (carbon dioxide flux across surface of, bomb-produced carbon-14 as tracer of, of Red Sea and Gulf of Aden) /Platygyra lamellina (carbon-14 bioaccumulation by, from seawater, historical trends in, carbon dioxide flux across seawater surface in relation to, in Red Sea and Gulf of Aden) /Environmental transport (of atm. carbon dioxide, across seawater surface, bomb-produced carbon-14 as tracer of, of Red Sea and Gulf of Aden)

61. CHESTER, R.; A.C. SAYDAM, and E.J. SHARPLES (DEP. OF OCEANOGRAPHY, THE UNIV., LIVERPOOL, L69)
AN APPROACH TO THE ASSESSMENT OF LOCAL TRACE METAL POLLUTION IN THE MEDITERRANEAN MARINE ATMOSPHERE.
MARINE POLLUTION BULLETIN, 1981, p. 426-431.

Assessing the extent of local trace metal pollution in marine atmospheric particulates presents a number of difficulties and 1 potential approach to the problem was evaluated by reference to a series of aerosols from the lower troposphere over the eastern Mediterranean. This region, which is less remote from the continents than open-ocean areas, has 2 significantly different atmospheric particulate catchments, being bordered in the north by nations having industrialized, semi-industrialized and rural economies, and in the south by the North African desert belt. The elemental chemistry of the particulates was illustrated in terms of the distributions of Fe and Pb, which were presented in the form of enrichment factor [EF] diagrams and was shown to be essentially controlled by the dilution of a European background material, common to remote regions of the latitudinal belt, with crust-derived, desert components. Major local perturbations in the dilution relationship occurred when crust-derived or pollutant components strongly dominated the total particulate population. The extent of these local perturbations was tentatively assessed using appropriate EF diagrams, which offered a framework within which to interpret the elemental chemistry of marine atmospheric particulates, providing sufficient data were available for their construction. By using such an EF diagram it was suggested that the eastern Mediterranean atmospheric particulates have not suffered local pollution on a gross scale with respect to Pb.
Index terms: IRON/LEAD/AIR POLLUTION MODEL

62. CHESTER, R.; E.J. SHARPLES; K. MURPHY; A.C. SAYDAM, and G.S. SANDERS (DEPARTMENT OF OCEANOGRAPHY, UNIVERSITY, LIVERPOOL

L69 3BX, GREAT BRITAIN)
THE ATMOSPHERIC DISTRIBUTION OF LEAD OVER A NUMBER OF MARINE REGIONS.
MAR CHEM, 1983, p. 57-72.

A data base of 111 filter-collected marine atmospheric particulates was used to describe the distribution of Pb over the North and South Atlantic, the Mediterranean Sea, the Red Sea, the Gulf of Aden and the northern and central Arabian Sea. The distribution of atmospheric Pb was assessed in terms of enrichment factor diagrams, and over the marine regions studied in the Northern and Southern Hemispheres the distribution of Pb in the atmosphere was controlled by the mixing of a background component, or components, with crustal material within certain concentration limits. For the Northern Hemisphere samples used in the investigation there was a reasonably well-defined Pb concentration minimum of .apprx. 0.6 ng/m3 air; this was severely decreased in more remote Northern Hemisphere marine regions. Geometric average Pb atmospheric concentrations varied from 1 marine region to another, ranging from .apprx. 0.98 ng/m3 air for the South Atlantic westerlies to .apprx. 15 ng/m3 air in the North Atlantic westerlies; although the latter reduced to .apprx. 7 ng/m3 air when polluted samples were excluded. Pb sea-surface deposition fluxes were calculated on the basis of 2 deposition velocities (0.25 and 1 cms), the largest flux (220 ng Pb cm-2 yr-1) being found for the westerlies over the eastern margins of the North Atlantic. The distribution of Pb over the North Atlantic was assessed in terms of the global Pb budget and it was estimated that a maximum of .apprx. 24% of the total natural Pb injected annually into the World atmosphere, and .apprx. 3.5% of the anthropogenic Pb injected annually into the Northern Hemisphere atmosphere, were deposited over the North Atlantic sea surface.
Index terms: METAL POLLUTION/AIR POLLUTION

63. CHESTER, R.; E.J. SHARPLES; G. SANDERS; F. OLDFIELD, and A.C. SAYDAM (THE UNIVERSITY, UK)
THE DISTRIBUTION OF NATURAL AND NON-CRUSTAL FERRIMAGNETIC MINERALS IN SOIL-SIZED PARTICULATES FROM THE MEDITERRANEAN ATMOSPHERE.
WATER AIR & SOIL POLLUTION, vol. 23, no. 1, p. 25-36, JUL 84.

MAGNETIC SUSCEPTIBILITY VALUES MEASURED IN 38 SOIL-SIZED PARTICULATES FROM THE MEDITERRANEAN SEA AND SURROUNDING REGIONS ARE USED TO ASSESS FACTORS CONTROLLING FERRIMAGNETIC MINERALS DISTRIBUTION IN THE MEDITERRANEAN AEROSOL. SOIL-SIZED

COMPONENTS GENERATED FROM THE NORTH AFRICAN DESERT BELT HAVE MUCH LOWER VALUES THAN THOSE ORIGINATING IN DESERTS LYING TO THE EAST OF THE MEDITERRANEAN. FERRIMAGNETIC MATERIAL, ESTIMATED ON THE BASIS OF MAGNETIC SUSCEPTIBILITY, IS A GOOD INDICATOR FOR TRACKING THE EXTENT OF MATERIAL TRANSPORT AND FOR ESTIMATING THE DEGREE OF INTER-POPULATION MIXING. (1 GRAPH, 2 MAPS, 14 REFERENCES, 2 TABLES) Index terms: MARINE ATMOSPHERE /AEROSOLS /MEDITERRANEAN SEA /AIR POLLUTION, NATURAL /STACK EMISSIONS /ATMOSPHERIC DIFFUSION PARTICULATE SIZE

64. Chieh, S.H. (Camp, Dresser and McKee, Inc., San Francisco, Cal.)
Two-dimensional numerical model of thermal discharges in coastal regions.
Journal of Hydraulic Engineering, vol. 113, no. 8, p. 1032-1040, Aug. 1987.

A two-dimensional numerical model of thermal discharge in coastal regions uses potential flow theory to calculate the ambient velocity field of the coastal water. To illustrate the computational procedure, the model was applied to the case of a recently developed industrial complex in the Red Sea region. The power and desalination plants of the industrial complex require a large amount of seawater for cooling purposes. The used cooling water is discharged into the Red Sea. Index terms: mathematical models/thermal pollution/path of pollutants/ coastal waters/model studies/pollutant transport/water temperature/ mapping/Red Sea

65. CLARK, W.S., and E. GORNEY (45534 Shetland Green Road, Alexandria VA 22312)
Oil contamination of raptors migrating along the Red Sea.
Environmental Pollution, vol. 46, no. 4, p. 307-313, 1987.

There are few accounts of oil contamination of raptors, and it has not been considered a threat for them. However, oil-based asphalt was found on 55 individuals of 9 species out of 1052 raptors (5.2%) captured and examined in the spring of 1985 and 1986 during a raptor migration study at Elat, Israel. Some were extensively contaminated and probably succumbed to the effects of ingested asphalt. The birds most likely picked up the contamination while drinking water from pools with surface oil. Examples of the contamination are described. Over 1.2 million raptors were counted passing Elat during the spring of 1985. IF 5% of these were contaminated, that would be over 60,000 birds, and this does not consider the raptors that migrate along the

Red Sea and do not pass near Elat, nor those that pass Elat unseen by the counters. Thus asphalt contamination could be major problem for raptors migrating along the Red Sea.
Index terms: Hydrocarbon/Contamination/Asphalt/Aves/Raptor/Israel/ Water pollution/Red Sea/Marine environment

66. Cohen, Yuval; Arie Nissenbaum, and Ronald Eisler (Dep. Oceanogr.; Hebrew Univ.; Jerusalem; Israel)
Effects of Iranian crude oil on the red sea octocoral Heteroxenia fuscescens.
Environ. Pollut., vol. 12, no. 3, p. 173-86, 1977.

Acute toxicity and sublethal effects of Iranian crude oil on colonies of the Red Sea octocoral Heteroxenia fuscescens were studied under continuous flow assay conditions. It was concluded that while crude oil may not be acutely toxic to Heteroxenia, exposure to high sublethal oil levels may result in long term deleterious effects.
Index terms: oil crude toxicity coral/Heteroxenia crude oil toxicity/ petroleum toxicity metab octocoral /Water pollution (by crude oil, octocoral in relation to) /Heteroxenia fuscescens (crude oil metab. and toxicity to) /Hydrocarbons, biological studies (in octocoral, after crude oil exposure) /Petroleum (metab. and toxicity of, to octocoral)

67. Coles, Stephen L., and Nazmi Gunay (Res. Inst.; King Fahd Univ. Pet. Miner.; Dhahran; Saudi Arabia)
Tar pollution on Saudi Arabian (Persian) Gulf beaches.
Marine Pollution Bulletin, vol. 20, no. 5, p. 214-18, May 1989.

The abundance of beach tar on Saudi Arabian Gulf beaches was surveyed over a 20 month period from May 1985 to October 1986. Tar abundance ranged up to ten times values previously reported for areas elsewhere in the Arabian Gulf and 100 times upper values reported for other world regions. Tar concentrations of greater than 10 kg/m of shoreline commonly occurred, while values in the 1-10 kg/m ranges were frequent. By comparison, beach tar concentrated for other areas have generally been in the g/m range. Beach tar abundances were highly variable in space and time, and the highest values obtained were more related to recent oil spills than to seasonal changes in prevailing oceanographic conditions. The importance of frequent and repetitive sampling to determine maximal beach tar abundances for an area is emphasized by these results.
Index terms: tar pollution Persian Gulf beach /Tar,petroleum (beach pollution by, of Persian Gulf, in Saudi Arabia) /Water pollution (by

tar, of beaches, of Persian Gulf, in Saudi Arabia)

68. **Concerned scientists alarmed at environmental implications of war in the Persian Gulf. (Persian Gulf crisis)(includes text of letter) (transcript).**
PR Newswire, Jan 15, 1991.

69. **Coral reefs of the world. Volume 2: Indian Ocean, Red Sea and Gulf.**
Nairobi, Kenya : UNEP ; Gland, Switzerland : International Union for Conservation of Nature and Natural Resources, 1988.
(UNEP regional seas directories and bibliographies)

70. Crain, O.L., and T.E. Allen (Aramco Services Co., Engineering Dept., 1200 Smith, Houston, TX)
A multifaceted approach to applying dispersants.
ASTM Committee F-20 symposium on hazardous substances and oil spill response, 1982.

Oil spill chemical dispersants: Research, experience and recommendations ASTM Special Technical Publication 840.
A comprehensive oil spill response plan has been developed partially to deal with accidental discharges of oil into the Arabian Gulf. The spill response capabilities of contractor companies in the area are fairly limited. The response plan relies on chemical agents and recovery as cleanup tools. The key to effective response is a rapid response and deployment of cleanup equipment. Initially, marine vessels equipped with portable dispersant spray booms patterned after the Warren Springs equipment were used. To improve existing oil spill response, an extensive modernization of dispersant deployment equipment has been developed. The areas of modernization include upgrading the marine vessel equipment, dedicating boats and vessels of opportunity for dispersant application, using helicopters for spill response, using large fixed-wing aircrafts for spill response, and establishing dispersant and refueling stockpiles. This paper discusses the use of dispersants in response to an oil spill. It is intended not as a scientific paper but as a paper on a local response capability.
Index terms: OIL SPILLS -- ENVIRONMENTAL EFFECTS/OIL SPILLS -- SURFACTANTS/OIL SPILLS -- WATER POLLUTION CONTROL/PERSIAN GULF SPILLS/PETROLEUM -- ENVIRONMENTAL EFFECTS /AIRCRAFT/CONTRACTORS/ EMERGENCY PLANS/OIL POLLUTION CONTAINMENT/ POLLUTION CONTROL EQUIPMENT/PORTABLE EQUIPMENT/SHIPS/SPRAYS /ARABIAN SEA/CONTAINMENT/ CONTROL/ENERGY SOURCES/ EQUIPMENT/FOSSIL

FUELS/FUELS/INDIAN OCEAN/ POLLUTION CONTROL/SEAS/ SURFACE WATERS

71. Dafni, J. (Hebrew Univ of Jerusalem, Israel)
Abnormal growth patterns in the sea urchin Tripneustes cf. gratilla (l.) under pollution (Echinodermata, Echinoidea).
J. Exp. Mar. Biol. Ecol. (Netherlands), vol. 47, no. 3, 7 Oct 1980.

Two populations of deformed sea-urchins were found near a combined power and desalination plant in the Gulf of Eilat, Red Sea. This area is highly polluted by thermohaline and heavy metal ion effluents. More than 60% of the urchins showed irregular bulging of the aboral half of the test. The height to diameter ratio for the most affected population was 0.70, compared with 0.53 for a normal population. The deformed sea-urchins had a wider peristome aperture and larger Aristotle's lantern, and fewer interambulacral plants than normal urchins of the same diameter. Growth rate of highly deformed urchins was very low. Growth lines in the deformed urchins' plates indicate excessive growth in the meridional direction. Some possible controlling mechanisms are suggested. (4 graphs, 1 map, 11 photos, 32 references, 3 tables)
Index terms: DUAL-PURPOSE POWER PLANTS -- ENVIRONMENTAL IMPACTS/SEA
URCHINS -- ANIMAL GROWTH/WATER POLLUTION -- TOXICITY /AQUATIC ECOSYSTEMS/DESALINATION PLANTS/POWER PLANTS /ANIMALS/AQUATIC ORGANISMS/ECHINODERMS/ECOSYSTEMS/ GROWTH/INDUSTRIAL PLANTS/ INVERTEBRATES/POLLUTION/POWER PLANTS

72. DAFNI, J. (HEBREW UNIV. JERUSALEM, H. STEINITZ MARINE BIOL. LAB., POB 469, EILAT, ISRAEL)
ABORAL DEPRESSIONS IN TESTS OF THE SEA-URCHIN TRIPNEUSTES-GRATILLA IN THE GULF OF EILAT RED SEA.
J EXP MAR BIOL ECOL, 1983, p. 1-16.

Flattening and aboral depressions occurred in high proportions in T. cf. gratilla (L.) populations that inhabited an artificial lagoon in the northern Gulf of Eilat, Red Sea. The average test height to diameter (H/D) ratio of the most affected population, near a small wastewater outlet, was 0.43 .+-. 0.01 (SE) and 76% showed aboral depressions. The H/D ratio was 0.54 .+-. 0.01 in populations outside the lagoon and < 1% exhibited aboral depressions. The exposure of normal T. cf. gratilla to industrial $CaCO_3$ precipitation inhibitors affected the growth and H/D ratio in a similar manner within 30-45 days. The light-weight tests of the deformed urchins and the occurrence of skeletal resorption in the interior part of the test

indicate that the unknown pollutant, possibly contained in laundry wastewater, reduced calcification by these animals and resulted in a mechanical collapse of the tests. A regular pattern of small pits at the aboral tip of the ambulacra suggests that intestinal mesenterial threads, attached to the test at the same points from within, facilitated this collapse by a mechanical pull. The normal test morphology of the regular echinoids may be regulated by the mechanical activity of various contractile and elastic tissue elements, among which mesenterial threads are probably included.
Index terms: CALCIUM CARBONATE/PRECIPITATION/POLLUTANT/MECHANICAL COLLAPSE

73. DAFNI, J. (THE HEBREW UNIV. H. STEINITZ MARINE BIOLOGY LAB., P. O. BOX 469, ELAT, ISRAEL)
SKELETAL DEFORMATIONS IN SEA-URCHINS DUE TO POLLUTION IN THE GULF OF ELAT RED SEA.
In the **18TH MEETING OF THE ZOOLOGICAL SOCIETY OF ISRAEL, SECOND SERIES,** 1981, p. 107-108. ISR J ZOOL
Index terms: TRIPNEUSTES-GRATILLA/GROWTH/INDUSTRIAL POLLUTION

74. Davis, Bob
Efforts to track mammoth oil spill are being impeded; lack of valid weather data, security concerns cited; water supply in jeopardy. (Persian Gulf war oil spill near Saudi Arabia).
Wall Street Journal, Jan 30, 1991, col 4, pA5(W) pA4(E).

75. Davis, Bob.
Mammoth oil spill draws ever closer to Jubail beaches. (Saudi Arabia, Persian Gulf).
Wall Street Journal, Feb 4, 1991, col 4, pA4(W) pA12(E).

76. Dayan, Uri, and Michael GraberShuval, Hillell. (Dep. Atmos. Sci.; Hebrew Univ.; Jerusalem; Israel)
Analysis of synoptic conditions in the Eastern Mediterranean (March 1979 to February 1980) that led to elevated air pollution concentrations in Israel.
Dev. Arid Zone Ecol. Environ. Qual., Proc. Int. Meet., Sci. Conf. Isr. Ecol. Soc., 12th.
Rehovot, Israel : Balaban Int. Sci. Serv., 1981. p. 383-97.
Index terms: weather air pollution Israel /Weather (air pollution in relation to, in Israel and eastern Mediterranean) /Air pollution (weather in relation to, in Israel and Eastern Mediterranean)

77. Degens, E. T. and John M. Hunt.
Data on the Distribution of Stable Isotopes and Amino Acids in Indian Ocean Sediments.
Woods Hole Oceanographic Institute, , Woods Hole, MA, 1968.
Geographic Area - Indian Ocean, Arabian Sea, Gulf of Oman.

Carbon-13, Carbon-12, and Oxygen-18/Oxygen-16 ratios were determined on the carbonate fraction of a series of cores from the Indian Ocean and compared with amino acid composition and mineralogy of the sediments. Observing station type: Ship. Observing station name: R/V Atlantis II, Cruise 15. Instrumentation: Core. Data collection type: Point Location. Number of Sites: 3. Number of observations - 1700. Date: March - April 1965.

78. Deutsches Hydrographisches Institut, Hamburg, West Germany.
Research Ship Meteor of the German Research Society and the German Hydrographical Institute. Voyage No. 33 (15 January - 5 April 1974) Atlantic Ocean - Mediterranean.1975. 111 p. Sponsored by Deut. Forschungsgemeinschaft.

The voyage was divided into two sections, each with different scientific aims. In the Atlantic, in the region of the Iberian Basin, and in the Western Mediterranean, radiological oceanographical investigations were carried out; in the eastern Mediterranean - north of Crete - geophysical-geological investigations. The disposition of wastes and the spreading of pollutants in seawater was studied in the Atlantic. The question of which seismical crust construction is present in the sea area north of Crete was investigated, together with a possible correlation between the anomalous crust construction of the Ionian and Tyrrhenian Seas.
Index terms: Atlantic Ocean/Mediterranean Sea/Oceanography/Research projects/ Oceanographic ships/Crusts/Hydrogeology/Waste disposal/Water pollution /Ocean waste disposal/Ocean dumping/Oceanographic surveys/ Translations/West Germany

79. DiBenedetto, William
Gulf war could spark devastating oil spills. (Persian Gulf).
Journal of Commerce and Commercial, Jan 14, 1991, v387 n27394, p1A(2).

80. DICKS, B. (Orielton Field Cent., Pembroke Dyfed SA71 5EZ, United Kingdom)
Oil and the black mangrove, Avicennia marina in the Northern Red Sea.
Marine Pollution Bulletin, vol. 17, p. 500, 1986.
Index terms: Water pollution/Marine environment/Hydrocarbon/Spill/ Mangrove/Red Sea

81. DICKS, B. (Orielton Field Cent., Dyfed, United Kingdom)
Oil pollution in the Red Sea. Environmental monitoring of an oilfield in a Coral Area, Gulf of Suez.
Mabahiss/John Murray international symposium 6. Deep-sea research. Part A. Oceanographic research papers, vol. 31, p. 833-854, 1984.
Index terms: Water pollution/Marine environment/Hydrocarbon/Coral reef/ Mangrove/Seagrass bed/Aves/Sampling/Cnidaria/Red Sea/Suez Canal/ Petroleum product

82. Dicks, B.; S.S. C. Westwood, and J. KuiperBrink, W.J. van den (Oil Pollut. Res. Unit, Field Stud. Counc., Orielton Field Cent., Pembroke, Dyfed, UK)
Oil and the mangroves of the northern Red Sea.
TNO Conf. on Oil Pollution. FATE AND EFFECTS OF OIL IN MARINE ECOSYSTEMS. PROCEEDINGS OF THE CONFERENCE ON OIL POLLUTION ORGANIZED UNDER THE AUSPICES OF THE INTERNATIONAL ASSOCIATION ON WATER POLLUTION RESEARCH AND CONTROL (IAWPRC) BY THE NETHERLANDS ORGANIZATION FOR APPLIED SCIENTIFIC RESEARCH TNO AMSTERDAM,.
DORDRECHT (NETHERLANDS) : MARTINUS NIJHOFF PUBL., 1987. p. 187-200.

Avicennia marina mangroves on South Geisum Island in the northern Red Sea were heavily oiled by a series of oil spills in 1982 and 1983. The oil was viscous and weathered, and formed a complete coating over pneumatophores. Although death of the mangroves was anticipated, the majority of trees survived. Field observations suggest sediment drainage characteristics influence pneumatophore density for this species and play a major role in determining the ability of the trees to survive heavy oiling. In order to test these hypotheses, further studies were carried out in April 1985 at 4 sites on South Geisum Island, which included obtaining measurements of Eh, interstitial water oxygen content and salinity, hydraulic conductivity, particle size distribution and hydrocarbon contamination as well as sampling infaunal communities.
Index terms: marine pollution/oil pollution/oil spills/Red Sea

83. Dixon, T. (Oil Pollution South East Kent, Dover, England)
Oil pollution on Israeli coasts.
Marine Pollution Bulletin, vol. 6, no. 5, p. 70-72, May 1975.

While Israeli coasts have experienced the effects of oil pollution from the Eastern Mediterranean for many years, a recent study now

indicates that there are additional inland problems originating from industrial waterways, general cargo ports, power stations, and oil ports which the government has had problems in effectively controlling. Recent increases in fines, detections for repeated offenses, and the availability of barges capable of receiving oil residues from shipping, are expected to reduce the problem. Additionally, oil spillage will be controlled by equipment from neighboring ports and oil terminal, and to add further controls power stations will be supplied with fuel oil by pipeline instead of tankers. The major areas of concern are the industrial waterway on the Kishon River near Haifa, the general cargo ports of Ashdod, Eilat and Haif and oil ports at Haifa, Ashkelon and Eilat. A general decline of marine microfauna and living corals near Eilat has recently been noticed; however, it is difficult to link these effects to any specific pollutant.
Index terms: oil pollution/oil spills/industrial wastes/Israel/water pollution sources/environmental effects/coasts/pollution abatement/ water pollution control

84. **DOE eyes impact of torching wells on Kuwait ecology.**
Platt's Oilgram News, Jan 23, 1991, v69 n16, p2(2).

85. Dolan, Maura
War affects ecology - but how? (potential environmental effects of Persian Gulf war) (column).
Los Angeles Times, Jan 20, 1991, v110 col 1, pA1.
ARTICLE TYPE: column

86. DOUABDUL, A.A. Z.; J.K. ABAYCHI; T.E. AL-EDANEE; A.A. GHANI, and H.T. AL-SAAD (Univ. Basrah, Marine Sci. Cent., Dep. Environmental Marine Chemistry, Basrah, Iraq)
Polynuclear aromatic hydrocarbons (PAHs) in fish from the Arabian Gulf.
Bulletin of Environmental Contamination and Toxicology, vol. 38, 1987.
Index terms: Hydrocarbon/Biological accumulation/Pisces/Polycyclic aromatic compound/Water pollution/Persian Gulf/Marine environment/ Edible fish .

87. DouAbul, A.A. Z (The University, Basrah, Iraq)
Petroleum residues in the waters of the Shatt al-Arab River and the northwest region of the Arabian Gulf.
Environ. Int. (United Kingdom), vol. 10, no. 3, 1984.

During April 1980, water samples were collected from 12 sites in the

Shatt al-Arab River and its estuary in the northwest region of the Arabian Gulf. The samples were extracted and the concentration of petroleum hydrocarbons were determined spectrofluorometrically, in order to provide information on the background values of oil generally present in these waters. Total hydrocarbon concentrations of these samples ranged from 2.7 to 86.7 ..mu..gL/sup -1/ expressed in terms of Kuwait crude oil equivalents. The highest concentrations were found at sites in the Shatt al-Arab River that are near port areas. 13 references, 1 figure, 2 tables.
Index terms: PETROLEUM RESIDUES -- ECOLOGICAL CONCENTRATION/WATER POLLUTION -- MONITORING /COASTAL REGIONS/EXPERIMENTAL DATA/IRAQ/OIL SPILLS/PERSIAN GULF/ SPATIAL DISTRIBUTION/SPECTROSCOPY /ARABIAN SEA/ ASIA/DATA/DEVELOPING COUNTRIES/ DISTRIBUTION/ENERGY SOURCES/FOSSIL FUELS/FUELS/INDIAN OCEAN/ INFORMATION/MIDDLE EAST/NUMERICAL DATA/ PETROLEUM/PETROLEUM FRACTIONS/POLLUTION/SEAS/SURFACE WATERS

88. Douabul, A.Z.; H.T. Al-Saad, and S.A. Darmoian (Basrah Univ., Iraq)
Distribution of petroleum residues in surficial sediments from Shatt al-Arab River and the North-west region of the Arabian Gulf.
Mar. Pollut. Bull. (United Kingdom), vol. 15, no. 5, p. 198-200, May 1984.

Samples of surface sediments were collected between November 1979 and April 1980 from 30 stations by Van Veen grab samplers. The procedure used for extraction and analyses of petroleum hydrocarbons in the sediment samples was based upon that of IOC, using a spectrofluorometer. API Kuwait crude oil was chosen as an arbitrary standard for comparison. In order to characterize the extracted hydrocarbons some of the samples were analysed by gas chromatography. The concentration of petroleum hydrocarbons in the sediment samples ranged from 0.4 ..mu..gg/sup -1/ at station 22 to 44.0 ..mu..gg/sup -1/ at station 9 dry weight, expressed as Kuwait crude oil equivalents. From the results presented here it is evident that, all the sites are contaminated to some extent with petroleum hydrocarbons. Oil pollution has possibly originated from at least two different sources; the first coming from refineries and port areas and the second source is probably due to tank-shipping operations. Sediment samples from three stations (17, 19 and 24) showed elevated levels of hydrocarbons (24, 20 and 22 ..mu..gg/sup -1/ Kuwait crude oil equivalents respectively) which may be due to the maintenance

dredging of Khawr Abdullar navigational channel.
Index terms: PERSIAN GULF -- WATER POLLUTION/PETROLEUM RESIDUES -- ECOLOGICAL CONCENTRATION/PETROLEUM RESIDUES -- POLLUTION SOURCES /CHEMICAL ANALYSIS/EXPERIMENTAL DATA/GAS CHROMATOGRAPHY/HYDROCARBONS/ PETROLEUM REFINERIES/RIVERS/SEDIMENTS/SPECTROPHOTOMETRY /ARABIAN SEA/ CHROMATOGRAPHY/DATA/ENERGY SOURCES/ FOSSIL FUELS/FUELS/INDIAN OCEAN/ INDUSTRIAL PLANTS/INFORMATION/ NUMERICAL DATA/ORGANIC COMPOUNDS/ PETROLEUM/PETROLEUM FRACTIONS/ POLLUTION/SEAS/SEPARATION PROCESSES/STREAMS/SURFACE WATERS

89. Douabul, A.A. Z.; H.T. Al-Saad; S.Z. Al-Obaidy, and H.N. Al-Rekabi (Dep. Environ. Mar. Chem., Mar. Sci. Cent., Univ. Basrah, Basrah, Iraq)
Residues of organochlorine pesticides in fish from the Arabian Gulf.
WATER AIR SOIL POLLUT, 1987, p. 187-194.
Special issue: *Acidification and anadromous fish of Atlantic estuaries.*

High-resolution electron capture gas chromatography was used to determine residue levels of organochlorine pesticides in 13 commercially important fish species collected from the NW Arabian Gulf. While most of the residues were below the detection limit of 1 mu g kg super(-1) wet weight, relatively low concentrations of Sigma DDT, endrin and dieldrin were detected in the edbile tissue of these fishes. The Sigma DDT residue levels ranged from 2 to 11 mu g kg super(-1) wet weight, endrin ranged from none detected (nd) to 45 mu g kg super(-1) and dieldrin from nd to 5 mu g kg super(-1). A definite correlation was established between total organochlorine pesticide residues and lipid content (r = 0.6) for the NW Arabian Gulf fishes. Comparison with fish from Hor-al-Hammar Lake (an area that used to be sprayed with pesticides) has shown that the latter contained significantly higher residue levels. The Sigma DDT residue levels ranged from 5 to 45 mu g kg super(-1) wet weight, endrin from 3 to 83 mu g kg super(-1) and dieldrin from nd to 4 mu g kg super(-1).
Index terms: pesticides (organochlorine)/residues/Persian Gulf/gas chromatography/fish/DDT/dieldrin/endrin/pollutant detection/pesticides

90. DOWIDAR, N.M. (Alexandria Univ., Fac. Sci., Dep. Oceanogr., Alexandria, Egypt)
Productivity of the South Eastern Mediterranean.
Natural and man-made hazards. International symposium, p. 477-498,

1988.
Published by D. Reidel, Dordrecht, Netherlands
Index terms: Pollution/Biota/Dams/Human activity/Nutrients/Floods/
Seasonal variations/Plankton/Egypt/East Mediterranean

91. Downing, N.
Coral reef communities in an extreme environment: the northwestern Arabian Gulf.
Proceedings of the Fifth International Coral Reef Congress, Tahiti, 1985.
vol. 2, p. 112.

92. DUCKLOW, HUGH W., and RALPH MITCHELL (Harvard Univ.)
A MODEL SYSTEM FOR THE STUDY OF SUBLETHAL POLLUTION EFFECTS ON
MARINE ORGANISMS.
JUL 1978. 41 p.
Report #: NTIS REPORT AD-A061 716.

A MICROBIAL ECOSYSTEM CONSISTING OF A CORAL AND ITS ASSOCIATED

BACTERIA THAT CAN BE USED AS A MODEL SYSTEM TO EXAMINE INTERACTIONS AMONG POLLUTANTS, CORALS, AND BACTERIA IS DESCRIBED. EXPERIMENTS THAT CHARACTERIZED CORAL MUCINS, PROTEINS, POLYSACCHARIDES, AND MUCAL FLOW MATERIAL ARE DISCUSSED. THE PRESENCE OF FUNCTIONING POPULATIONS OF CULTURABLE BACTERIA IN THE SUPERFICIAL MUCUS LAYERS OF THREE CORAL SPECIES IS DEMONSTRATED. AN EXPERIMENTAL FLOWING WATER SYSTEM IN WHICH THE RED SEA SOFT CORAL HETEROXENIA FUSCESENS IS EXPOSED TO SUBLETHAL CONCENTRATIONS OF CRUDE OIL IS EXAMINED.
Index terms: MARINE POLLUTION EFFECTS /MARINE ORGANISMS /MATHEMATICAL MODELS-MARINE /CORAL REEFS /BACTERIA /FOOD CHAINS/DIALOG

93. **Egypt denounces Iraq's alleged oil spill tactic.**
Japan Economic Newswire, Jan 26, 1991.

94. Ehrhardt, Manfred, and Ali Douabul (Inst. Meereskd.; Univ. Kiel; Kiel; Fed. Rep. Germany)
Dissolved petroleum residues and alkylbenzene photo-oxidation products in the upper Arabian (Persian) Gulf.
Mar. Chem., vol. 26, no. 4, p. 363-70, July 1989.

Lipophilic dissolved material was concentrated by in-situ liquid-solid

adsorption on Amberlite XAD-2 resin from glass-fiber-filtered coastal seawater in the upper Arabian Gulf in the fall of 1986. Ten percent aqueous acetone was used for countercurrent desorption under reflex. In the concentrated elute petroleum components were characterized and quantified by GC-MS as were ketonic photo-oxidation products of alkylbenzens. Concentrations of the photo-oxidation products exceeded those of unaltered petroleum components by roughly a factor of ten. Index terms: petroleum pollution seawater Persian Gulf/alkylbenzene photooxidation product Persian Gulf /Water pollution (by petroleum, photooxidn. of alkylbenzene components in, in upper Persian Gulf) / Petroleum (seawater pollution by, photooxidn. of alkylbenzene components in relation to, in upper Persian Gulf)

95. Eisler, R.; Kissill, G.W., and Cohen, Y. (Natl. Water Res. Ctr., Naragannsett, RI.)
Biological effects of crude oils and oil-dispersant mixtures on Red Sea macrofauna.
U.S. Environ. Prot. Agency, Off. Res. Dev., 1974. p. 156-79.
Report #: EPA, NEPA 600-4-74.
Index terms: review oil dispersant pollution/oil spill marine fauna review/ocean oil spill fauna review /Animal (aquatic, oil spills effect on)/Water pollution (by oil spill dispersants and oil, marine animals response to) /Dispersing agents (oil spill, marine animals response to oil and) /Petroleum/Waters, ocean (oil spills, aquatic animals response to)

96. Eisler, R.; G.W. Kissill, and Y. Cohen (National Marine Water Quality Lab., West Kingston, R.I.)
Recent studies on biological effects of crude oils and oil-dispersant mixtures to Red Sea microfauna.
Proceedings of Seminar on Methodology for Monitoring the Marine Environment.
Washington, D.C. : U.S. EPA, Office of Research and Development., Oct. 1974. p. 157-179.
(Environmental monitoring series, ; EPA-600/4-74-004)

Because virtually nothing was known regarding the influence of crude oil or chemical oil counteractants on local coral reef ecosystems, in 1972 the Hebrew University initiated a continuing series of investigations in this subject area. Progress during the first year of laboratory studies was summarized. Specifically acute toxicity to representative species of marine macrofauna of two common grades of crude oils, a chemical oil dispersant used extensively in Northern Israel and mixtures of oil and dispersant at realistic application

levels, was reported. Bioassays were conducted under static as well as continuous flow conditions. Depth-toxicity interactions were evaluated by using deep (2.0 m) tanks. Sublethal and latent effects of crudes and oil-dispersant mixtures on physiology, metabolism, and behavior were investigated as were short-term degradation and bioaccumulation of oil.
Index terms: bioassay/oil pollution/water pollution effects/oil spills/oil/toxicity/laboratory tests/sea water/aquatic animals/marine biology/marine animals/bioindicators/biology/Red Sea/Israel

97. Eisler, Ronald (Heinz Steinitz Mar. Biol. Lab.; Hebrew Univ. Jerusalem; Elat; Israel)
Acute toxicites of crude oils and oil-dispersant mixtures to Red Sea fishes and invertebrates.
Isr. J. Zool., vol. 24, no. 2, p. 16-27, 1975.

Crude oil from fields in the Persian Gulf and in the Sinai plus a chemical oil dispersant were tested, using static bioassay procedures, for toxicity to adults or juveniles of ten marine species: Heteroxenia fuscescens, a soft coral; Nerita forskali and Drupa granulata, gastropod molluscs; Mytilus variabilis, a mussel; Acanthopleura haddoni, a chiton (mollusc); Echinometra mathaei, sea urchin; Calcinus latens, a hermit crab; Palaemon pacificus, a shrimp; Parupeneus barberinus, goatfish; and Siganus rivulatus, rabbitfish.
Concentrations fata to 50% of individual test species in 168 hours, LC-50 (168 h), ranged form 0.74 to more than 30.0 ml/liter for Persian Gulf crude, from 14.5 to more than 30.0 ml/liter for Sinai crude, and from 0.006 to 0.064 ml/liter for the dispersant. In general, fishes and crustaceans were the most sensitive groups assayed and molluscs the most resistant. LC-50 (168 h) values for oil-dispersant mixtures of 10 parts oil to 1 part dispersant (v/v) for selected species ranged from 0.047 to 0.152 ml/liter which appears to reflect the biocidal properties of the dispersant. Some individuals that survived immersion in high concentratiosn of the test compounds for 168 h were adversely affected during treatment and afterwards.
Index terms: oil toxicity fish invertebrate/mollusk oil toxicity/water pollution oil toxicity /Animal (aquatic invertebrate, crude oils and oil-dispersant toxicity to, of Red Sea) /Water pollution (by crude oils and oil-dispersants, aquatic animals in relation to) /Fish (crude oils and oil-dispersants toxicity to, of Red Sea) /Dispersing agents (for oil spill, toxicity of, to fish and invertebrates, of Red Sea) / Ecology (of crude oils and oil dispersants, aquatic animals in relation to) /Petroleum (toxicity of, to fish and invertebrates, of Red Sea)

98. Eisler, Ronald (Heinz Steinitz Mar. Biol. Lab.; Hebrew Univ. Jerusalem; Elat; Israel)
Latent effects of Iranian crude oil and a chemical oil dispersant on Red Sea mollusks.
Isr. J. Zool., vol. 22, no. 4, p. 97-105, 1973.

Predation rate of the gastropod drill, Drupa granulata, on the mussel, Mytilus variabilis, was measured over a period of 28 days after adults from both species had been immersed for 168 h in seawater solutions containing high sublethal concentrations (10 ml/liter) of Iranian crude oil. Predation rate was three times higher in controls than in the group where both predator and prey had been exposed initially; intermediate values were determined among groups where only one species had been treated initially. Fecundity of drills, as evidenced by number of egg cases deposited, was directly related to mussel consumption. In a similar study with a chemical oil dispersant, exposure to high (0.003 ml/liter) sublethal levels for 168 h did not affect markedly the rate at which mussels were destroyed and consumed during post-treatment. However, the fecundity of untreated drills feeding on untreated mussels (controls) was 3 to 10 times greater than among groups in which one or both species had been exposed initially to dispersant. Except for mussels consumed by drills, there were no deaths during the post-treatment period in either study, and all organisms appeared normal.
Index terms: oil dispersant mollusk/ecol crude oil mollusk /Drupa granulata/Mytilus variabilis (crude oil and chem. oil dispersant effect on) /Reproduction (crude oil and chem. oil dispersant effect on, in mollusks) /Petroleum (Drupa granulata and Mytilus variabilis response to) /Ecology (environmental damage, by crude oil aad chem. oil dispersant, mollusks in relation to) /Dispersing agents (for oil spills, Drupa granulata and mytilus variabilis response to)

99. Eisler, Ronald (Natl. Mar. Water Qual. Lab.; U. S. Environ. Prot. Agency; Narragansett; R.I.)
Toxic, sublethal, and latent effects of petroleum on Red Sea macrofauna.
1975 Conference on Prevention and Control of Oil Pollution: Proceedings.
Washington, D. C.: Am. Pet. Inst., 1975. p. 535-40.

The effects of crudes and a chemical oil counteractant on survival, metabolism, and behavior of representative species of Red Sea macrofauna under controlled environmental conditions were examined.

The action of crude oil from fields in Iran and in the Sinai, a chemical oil dispersant, and oil-dispersant mixtures on juveniles or adults of octocorals, crustaceans, molluscs, echinoderms, and teleosts were studied. The choice of bioassay, methodology on response parameters, especially survival, is significant. A comparison of toxicity values derived from tests in large (1,500 l), deep (2.0 m) tanks under conditions of continuous flow with those performed in small (3 l) jars under static conditions demonstrated that most assay species were up to 30 times more resistant to almost all toxicants in large tanks. Tank tests also demonstrated a protective effect with increasing depth: organisms confined 1.0 to 1.8 m from the surface exhibited higher survival than those held at shallower depths. Sublethal and latent effects of oils and dispersants on Red Sea biota were reviewed and included reduction in feeding rate and egg case deposition of predatory gastropods, interference with substrace attachment by mussels, liver enlargement and lowered blood hematocrit values in fishes, and bioaccumulation of crude oils in octocorals. These and other data presented herein suggest that introduction of petroleum into Red Sea ecosystems may disrupt established feeding-predator patterns, reproductive processes, defense mechanisms, and conceivably other systems, and it would constitute a potential threat to population stability.
Index terms: petroleum dispersant marine toxicity/oil dispersant marine toxicity/water pollution oil dispersant /Water pollution (by petroleum and dispersant, marine macrofauna response to) /Animal (marine, petroleum and dispersant toxicity to) /Petroleum (toxicity of, to marine macrofauna)

100. El Deeb, K.Z., and Ebiary, E.H. El- (Mar. Sci. Dep., Fac. Sci., Univ. Qatar, Doha, Qatar)
Total aromatic hydrocarbon content in the muscle and liver lipid extracts of two seabream fishes from the Arabian Gulf.
ARAB GULF J. SCI. RES. B: AGRIC. BIOL. SCI, 1988, p. 139-151.

Concentrations of total aromatic hydrocarbons (TAHC) were determined in two seabream fishes from the Family Sparidae, longspine seabream, Argyrops spinifer (Kofar) and Mylio bifasciatus (Faskar) from the eastern and southeastern coasts of Qatar. Levels of total hydrocarbons in the muscle and liver tissues of Argyrops sp. were lower than those in Mylio sp. Variations in TAHC with size were very slight in Argyrops sp. while Mylio sp. showed significant variations in both muscle and liver tissues. The hydrocarbons contained, in the two fishes displayed, high aromatic concentrations correlated with increasing fat content. Mean concentrations of total aromatic

hydrocarbons in the muscle and liver tissues of Argyrops sp. were 24.7 and 23.7 mu gg super(-1) while in Mylio sp. they were 53.4 and 41.1 mu gg super(-1) wet weight chrysene equivalents respectively.
Index terms: liver/Argyrops spinifer/Mylio bifasciatus/ bioaccumulation/marine pollution/polycyclic aromatic hydrocarbons/ Qatar/Persian Gulf

101. El Samra, M.I., and Deeb, K.Z. El (Mar. Sci. Dep.; Univ. Qatar; Qatar)
Horizontal and vertical distribution of oil pollution in the Arabian (Persian) Gulf and the Gulf of Oman.
Marine Pollution Bulletin, vol. 19, no. 1, p. 14-18, 1988.
Index terms: oil pollution distribution Arabian Gulf/seawater pollution petroleum Arabian Gulf/Waters, ocean (oil spills on, vertical and horizontal profile of, of Arabian Gulf) /Petroleum, oil spills(on seawater, distribution of, of Arabian Gulf)

102. EL SAMRA, M.I.; H.I. EMARA, and F. SHUMBO (Univ., Marine Sci. Dep., Qatar)
Dissolved petroleum hydrocarbon in the northwestern Arabian Gulf.
Marine Pollution Bulletin, vol. 17, 1986.
Index terms: Water pollution/Seawater/Persian Gulf/Hydrocarbon/Coastal zone/Kuwait/Saudi Arabia/Qatar

103. El-Rayis, OsmanA.; M.M. Abbas, and A.A. Qurashi (Fac. Mar. Sci.; King Abdulaziz Univ.; Jeddah; Saudi Arabia)
Distribution of chemical pollutants in Jeddah coastal waters, Red Sea. I. Phosphate and silicate.
J. Fac. Mar. Sci. (King Abdulaziz Univ.), vol. 2, p. 73-80, 1982.
Index terms: phosphate coastal seawater sewage pollution/silicate coastal seawater sewage pollution/nutrient coastal seawater sewage pollution/ocean coastal nutrient sewage pollution /Water pollution (by sewage, seawater phosphate and silicate and nutrient levels in relation to, of Red Sea coast)/Phosphates, biological studies (in waters, sewage pollution effect on, of Red Sea coast)

104. Ellis, David
Time, Jan 21, 1991, v137 n3, p19(1).

105. ELLIS, DEREKV. (UNIV OF VICTORIA, CANADA)
A DECADE OF ENVIRONMENTAL IMPACT ASSESSMENT AT MARINE AND COASTAL MINES.
MARINE MINING, vol. 6, no. 4, p. 385(33), 1987.

CASE HISTORIES ARE SUMMARIZED AS A MEANS OF UNDERSCORING PROGRESS IN ENVIRONMENTAL IMPACT ASSESSMENT AND CONTROL RELATIVE TO MARINE AND COASTAL MINING OPERATIONS. ADVANCES ARE NOTED STEMMING FROM THE ATLANTIS II DEEP PRE-PILOT MINING OPERATION IN THE RED SEA, AND FROM MANY COASTAL MINES AND SMELTERS WHICH DISCHARGE THEIR WASTES TO THE SEA. THE DOCUMENTED CASE STUDIES ILLUSTRATE FOUR PRIMARY IMPACTS: TURBIDITY, SEABED SMOTHERING, CONTAMINATION, AND TOXICITY; THESE CAN LEAD TO FOUR DERIVED IMPACTS: REDUCED BIOLOGICAL PRODUCTIVITY, CONTAMINANT BIOMAGNIFICATION, SEAFOOD PATHOLOGIES, AND STOCK MORTALITIES. (1 GRAPH, 75 REFERENCES, 9 TABLES)
Index terms: OCEAN MINING/ENV IMPACT ASSESSMENT/COASTAL WATERS/ WASTEWATER OUTFALLS /MINERAL REFINING /SMELTERS /MANGANESE RESOURCES/MINE TAILINGS /MARINE POLLUTION EFFECTS

106. Emara, H.I., and Deeb, K.Z. El (Mar. Sci. Dep.; Univ. Qatar; Doha; Qatar)
Distribution of dissolved petroleum hydrocarbon in the southern Arabian Gulf.
Arab Gulf J. Sci. Res., A, vol. 6, no. 2, p. 191-203, 1988.
Index terms: petroleum pollution seawater Persian Gulf /Water pollution (by petroleum hydrocarbons, of Persian Gulf) /Waters, ocean (petroleum hydrocarbons in, of Persian Gulf) /Petroleum, oil spills (seawater pollution by hydrocarbons from, in Persian Gulf)

107. Emara, H.I. ; El-Samra, M.I. and El-Deeb, K.Z.
A preliminary study on the chemical characteristics of the Qatar waters, Gulf area.
Proceedings of the Fifth International Coral Reef Congress, Tahiti, 1985. vol. 2, p. 120.

108. **Engulfed. (environmental aspects of Iraq's deliberate oil spill in the Persian Gulf) (Scorecard).**
Sports Illustrated, Feb 4, 1991, v74 n4, p9(1).

109. Enstop, J.
Heavy Metals in Tunisia.
Whaling Geographic Area - Mediterranean Sea, Coastal, Tunisia, Tunis, Lagoons.

Two Year Survey (Jan. 1973 - Dec. 1974) of Heavy Metals in Three Tunisian Lagoons. Analysis included water, sediment, and tissues from algae, annalids, and fish. Contains essentially all tritium results obtained on oceanic samples collected

between 1965 and early 1972, processed by the University of Miami laboratory, with exception of those from the GEOSECS test cruises. The work was supported lby NSF. The samples were collected by various platforms and operators. Depth, temperature, and salinity have been obtained through the chief scientist of each expedition, or his institution.

110. ERZINCLIOGLU, Y.Z.; J.M. BAKER, and S.E. HOWELLS (FSC RES. UNIT, DEP. ZOOL., UNIV. CAMBRIDGE, DOWNING ST., CAMBRIDGE CB2 3EJ, UK.) **CYCLORRHAPHOUS MAGGOTS FROM A HYPERSALINE OIL SPILL SITE.** ENTOMOLOGIST, vol. 109, no. 4, p. 250-255, 1990.

The larvae of cyclorrhaphous flies were found in an oil-polluted mangrove area on an island in the Arabian Gulf. Insects inhabiting crude oil are previously known only from California [USA], where the larvae of the species Psilopa petrolii occur in oil seepages. Further investigations on this insect are encouraged.
Index terms: PSILOPA-PETROLII/LARVAE/POLLUTED/MANGROVE/PERSIAN GULF/CALIFORNIA USA

111. FAYAD, N.M. (Univ. Petroleum Mineral, Res. Inst, Dharan, Saudi Arabia)
Identification of tar balls following the Nowruz oil spill.
Marine Environmental Research, vol. 18, 1986.
Index terms: Water pollution/Seawater/Hydrocarbon/Tar/Spill/Persian Gulf/Chemical analysis

112. **Fire out, oil flow halted into Persian Gulf. (Kuwait).**
Japan Economic Newswire, Jan 29, 1991.

113. Fishelson, L. (George S. Wise Cent. Life Sci.; Tel-Aviv Univ.; Tel-Aviv; Israel)
Stability and instability of marine ecosystems, illustrated by examples from the Red Sea.
Helgol. Wiss. Meeresunters., vol. 30, no. 1-4, p. 18-29, 1977.
Index terms: marine ecosystem pollution instability /Coral, reef (instability of ecosystem of, water pollution in relation to) /Water pollution(of coral reef, ecosystem changes in relation to) /Ecology (of coral reef, water pollution in relation to stability of)

114. Fowler, S.W.
PCBs and the environment: the Mediterranean marine ecosystem.
Waid, John S., editor.
PCBs and the Environment: Volume III of a three volume set.
Boca Raton, Fla. : CRC Press, 1987. p. 209-239.

Because of unique oceanographic and geographic characteristics, the Mediterranean Sea is vulnerable to the effects of anthropogenic pollutants such as polychlorinated biphenyls (PCBs). The major input sources are rivers in the northwestern sector, including the Adriatic Sea, and atmosphere fallout originating from industrial and urban areas of continental Europe. Concentrations of PCBs in coastal waters are higherly variable and indicate the influence of coastal sources. Offshore levels of PCBs are lower and generally more uniform. PCB levels in open waters of the western Mediterranean tend to be slightly higher than those in the eastern basins. A trend toward reduction in PCB input during the latter half of the 1970s in open waters has been noted. Concentrations of PCBs in coastal sediments are high near input sources such as urban and industrial outfalls, but rapidly drop off in a seaward direction displaying levels more typical of Mediterranean deep-sea sediments. PCB concentrations in coastal sediments from the eastern Mediterranean are low and fall within the range of values characteristic of levels in sediments from the open sea.
Index terms: polychlorinated biphenyls/Mediterranean Sea/marine animals/water pollution effects/path of pollutants/environmental effects/ecosystems/bioaccumulation/ecological effects/marine sediments/marine plants/biomass/plankton/air pollution/water pollution sources

115. FOWLER, S.W.; L. HUYN-NGOC, and R. FUKAI (Musee oceanographique, Monte Carlo , Monaco)
Dissolved and particulate trace metals in coastal waters of the Gulf and western Arabian Sea.
Mabahiss/John Murray international symposium 6. Deep-sea research. Part A. Oceanographic research papers, vol. 31, 1984.
Index terms: Trace elements/Heavy metals/Copper/Zinc/Cadmium/Mercury/Lead/Dissolved materials/Particles/Sea water/Coastal environment/Pollution/Persian Gulf/Gulf of Oman/Arabian Sea/Heavy metal

116. FRAZIER, J., and S. SALAS (Dept. of Zool. Res., Natl. Zool. Park, Smithsonian Inst., Washington DC)
The status of marine turtles in the Egyptian Bred Sea.
Biological Conservation, vol. 30, 1984.

Five species of marine turtles occur in the Egyptian Red Sea, and 3 are recognized by local fishermen: Eretmochelys imbriacata (L.), Chelonia mydas (L.) and Dermochelys coriacea (L.). The last named is rarely sighted, and although the other 2 nest, only Eretmochelys is common; possibly 500 nest yearly, mainly on offshore islands. Both nesting and feeding habitats appear to be extensive for this species,

but clutches have an unusually high percent of yolkless eggs. The significance of this is not understood, but it indicates that the animals are under pressures not experienced in other parts of their range. The small population of Chelonia is probably due to the scarcity of feeding habitat; marine pastures are generally small in area and standing crop. Dermochelys may be rarely sighted because local fishermen infrequently venture into epipelagic waters, where this animal is most common, but the available data indicate that the species is a vagrant in Egypt. The enormous swarms of jellyfish that occur in the Egyptian Red Sea evidently do not attract these turtles, although seasonal concentrations of jellyfish are often accompanied by Dermochelys in other seas. Exploitation of turtles, mainly for meat and eggs is slight, but habitat pertubations from oil pollution and marine explosions are intense. There is a great need for more basic information and rigorous management of the marine environment.
Index terms: Chelonia/Marine environment/Red Sea/Faunal survey/ Fishing/Animal conservation/Commercial use/Oil Pollution/Jellyfish/ Feeding/Habitat

117. Ganor, E.; Y. Mamane, and A.E. Donagi
Aerosol composition of urban and desert origin in the Eastern Mediterranean, I.
Water, Air, and Soil Pollution, vol. 14, p. 29-?, 1980.
Index terms: aerosol composition/Mediterranean Sea/air pollution monitoring

118. GANOR, E., and Y. MAMANE (ENVIRONMENTAL WATER RESOURCES ENGINEERING, TECHNION, HAIFA, ISRAEL)
TRANSPORT OF SAHARAN DUST ACROSS THE EASTERN MEDITERRANEAN.
ATMOS ENVIRON, 1982, p. 581-588.

Earlier studies estimated the production of natural dust from the Sahara Desert to be between 200-260 million ton/yr. These figures were based solely on the westward transport of Saharan dust. Estimates on the dust transport to the eastern Mediterranean were provided. Data were obtained from several studies concerned with dust storms in Israel, including ground and airborne particle mass concentration, vertical profiles, dust storm trajectories, particle deposition and the climatology of dust storms in the eastern Mediterranean. A simple 2 dimensional transport model applied to the data yielded a production rate of 70 million tons Saharan dust/yr which were transported eastward; .apprx. 1/3 of this amount reached the eastern Mediterranean coast located 2000 km from the Saharan source.

Index terms: AIR POLLUTION MODEL

119. Gellman, Barton
Theories vary on motive for spill; was terror or creating defense barrier the goal. (The Persian Gulf War).
Washington Post, Jan 26, 1991, v114 col 1, pA13.

120. Gerges, M.
Satellite in action in ROPME Sea Area.
The Siren, no. 36, p. 23-25, Apr. 1988.

121. Geyer, H.; D. Freitag, and F. Korte (Inst. Oekol. Chem., Gesellschaft Strahlen- und Umweltforsch. mbH Muenchen, Ingolstaedter Landstr. I, D-8042 Neuherberg, FRG)
Polychlorinated biphenyls (PCBs) in the marine environment, particularly in the Mediterranean.
Ecotoxicology and Environmental Safety, April 1984, p. 129-151.

The concentrations of PCBs in marine air, water, sediments, microplankton, algae, mussels, fish, and other marine organisms including seabirds from the Mediterranean area are reviewed and compared with PCB concentrations in marine samples from non-Mediterranean regions. Levels of PCBs in seawater are highest in the western and central Mediterranean. The data for mussels and fish give a clear indication that the PCB levels are higher in the Northwest and the Tyrrhenian Sea than in the eastern Mediterranean. The FDA in June 1979 set 2 mg/kg as the temporary maximum concentration for PCBs in fish and shellfish. The PCB residues in some fish from the northwestern Mediterranean and Tyrrhenian Sea and in some mussels from the Adriatic Sea are higher than this limit.
Index terms: aquatic organisms/Mediterranean Sea/bioaccumulation/ environmental impact/PCB compounds/marine pollution

122. GHOBRIAL, F.H. (Kuwait Inst. Sci. Res., Safat 13109, Kuwait)
Environmental impact assessment of dredging a navigation channel in Kuwait waters.
International Conference on Coastal and Port Engineering in Developing Countries. 2, vol. 2, 1987.
Index terms: Impact statements/Channels/Dredging/Bays/Water quality/ Sea water/Ecosystems/Pollution/Sediments/Heavy metals/Kuwait/Persian Gulf

123. Gideiri, Y.B. A (Saudi-Sudanese Joint Red Sea Commission, Jeddah)

Impacts of mining on central Red Sea environment.
Deep-Sea Res., Part A (United Kingdom), vol. 31, no. 6-8A, 1984.

The mining of the Atlantis II deep will result in a significant input of heavy metals into the Red Sea. Quantities of dissolved compounds will result in major changes in the trace element composition of the water masses. The dissolution of minerals resulting in the release of toxic chemicals including zinc, copper, cadmium and mercury remains of fundamental concern which will require further study. The regime for discharge of tailings must be designed to minimise the dispersal of the solids, and also the fluids together with their dissolved leached constituents. If the discharges occur deep down the waste will be confined to the deep waters in the central graben, where the absence of significant upwelling combined with the natural chemical processes of removal via sorption will restrict the dispersal of the toxic substances. Research on biological activity within the epipelagic and mesopelagic zones has led to the recommendation that all wastes should be restricted to the bottom water below 1100 metres. A consideration of the likely effect upon benthos and water chemistry has demonstrated that tailings will have to be confined to the central graben, in order to protect local fisheries and the vulnerable reef and seabed environments of the coasts and the Central Trough. However, discharge of the tailings at depth would also limit the transmission of the tailing pollutants through the food web. It should, therefore, confine the effects of mining to a limited portion of the Red Sea biota. The shallower release of tailings within the zone of diel migration by plankton and nekton would expose a large community of organisms to the pollutants and result in the vertical transport of heavy metals up the water column.
Index terms: MINING -- ENVIRONMENTAL EFFECTS/MINING -- WATER POLLUTION ABATEMENT/RED SEA -- POLLUTION SOURCES/RED SEA -- WATER POLLUTION ABATEMENT/TOXIC MATERIALS -- ECOLOGICAL CONCENTRATION/TOXIC MATERIALS -- ENVIRONMENTAL EXPOSURE PATHWAY

124. GIDEIRI, Y.B. A. (Saudi-Sudanese Red Sea joint Commission, Jeddah, Saudi Arabia)
Implications of sea mining for the Red Sea environment.
Hydrobiologia, vol. 110, 1984.
Index terms: Pollution/Marine environment/Heavy metal/Mining/ Ecosystem/Red Sea /

125. GOLIK, A.; A. ABERBACH, and S. AMIR (National Inst. Oceanogr., Haifa, Israel)
Coal : A new pollutant in the Eastern Mediterranean?

Congres-assemblee pleniere de la C.I.E.S.M. 30 Rapp. P-V. Reun. - Comm. int. Explor. Sci. Mer Mediterr, vol. 30, 1986.
Index terms: Coal/Pollution/Sea water/East Mediterranean/Israel

126. Green, M.J.B. and Drucker, G.R.F.
Current status of protected areas and threated mammal species in the Sahara-Gobian Region.
Report of the World Conservation Monitoring Centre, 1990.

127. Grimalt, J.; J. Albaiges; H.T. Al-Saad, and A.A. Z Douabul
n-Alkane distributions in surface sediments from the Arabian Gulf.
NATURWISSENSCHAFTEN, 1985, p. 35-37.

The study of hydrocarbons in recent sediments from the Arabian Gulf deserve major interest from different standpoints. On the one hand, one third of the world's petroleum production and two-thirds of the oil tanker traffic takes place in this area, therefore a chronic input of petroleum hydrocarbons into the sediments is to be expected. ON the other hand, the Arabian Gulf has a relatively small and shallow water body, especially in its northern part, with restricted circulation and high temperatures (> 30 degree C) and salinities (up to 40 ppt) that provide favourable conditions for oil degradation. In spite of this, only few studies have been conducted at present in this area which are mostly related to the pollution of biota. In an attempt to use surface sediments for oil-pollution monitoring on the Iraqi coast, unusual n-alkane distributions, apparently not directly related to petroleum sources were found. Occurrence can only be explained by the particular environmental conditions prevailing in the area.
Index terms: Persian Gulf/hydrocarbons/sediments/pollutant detection/ chemistry

128. Grosch, M., and Wolf, G. (Inst. Meteorol. Geophys.; Frankfurt Univ.; Frankfurt/Main; Germany)
Neutron activation analyses of mercury, arsenic, bromine, and antimony in atmospheric aerosols. 1977. 8 p.
Report #: Report, NAED-CONF-77-537-002, Available from NTIS.
Meeting on Aerosols in Natural Science, Medicine and Technology-Measurement Techniques and Technical Applications, Karlsruhe, F.R. Germany, Oct. 26, 1977.
Index terms: antimony pollution atm aerosol/arsenic pollution atm aerosol/mercury pollution atm aerosol/bromine pollution atm aerosol /Aerosols,airborne (air pollution by, contg. antimony and arsenic and bromine, and sources thereof) /Atmosphere (bromine-contg.

aerosols in, in Jerusalem area, from Red Sea) /Waters, ocean (bromine-contg. atm. aerosols from, of Red Sea) /Air pollution (by aerosols contg. antimony and arsenic and bromine and mercury, and sources thereof) biological studies, air pollution by aerosols contg., and sources thereof

129. **Gulf oil slick remains unchecked. (Persian Gulf).**
Japan Economic Newswire, Jan 26, 1991.

130. **GULF OIL SPILL PROGRESSES SOUTH.**
United Press International, Feb 7, 1991.

131. **GULF SPILL THREATENS ECOLOGICALLY UNIQUE REEFS.**
United Press International, Feb 1, 1991.

132. **Gulf War intensifies as Iraq destroys Kuwaiti oil wells.**
Japan Economic Newswire, Jan 22, 1991.

133. Gundermann, N., and D. Popper (Tel-Aviv Univ., Dept. of Zoology, Tel Aviv, Israel)
Some aspects of recolonization of coral rocks in Eilat (Gulf of Aqaba) by fish populations after poisoning.
Marine Biology, vol. 33, no. 2, p. 109-118, 1975.

As a result of an accident, a limited strip of the coast of Eilat (Gulf of Aqaba, Red Sea) was affected by pesticides and chemicals that killed all the fishes. The area was observed monthly for the following year, to study the recovery of fish populations. The study also included observations on growth rate of fish and size populations. Recovery of fish populations was complete 10 to 12 months after the poisoning. It is believed that this is due to the relatively small size of the contaminated area and the survival of most invertebrates that constitute an important part of the biotope of the fish.
Index terms: fishkill/poisons/toxicants/pesticides/juvenile fish/food webs/benthos/chemical wastes/coral/fish populations/water pollution effects/aquatic habitats/tropical regions/aquatic environments/fish behavior/algae/Endrin/growth rates/reefs/recolonization/tropical fish/ Damsel fish/barracuda/lion fish/Scaridae/Labridae/Sparidae/Ciandrin/ Ariosal/Kavion/Red Sea

134. Hamilton, E.I. (Basrah Univ., Marine Science Center, Iraq.)
Distribution of oil-degrading bacteria in the Northwest Arabian Gulf.
Marine Pollution Bulletin, vol. 21, no. 1, p. 38-40, Jan. 1990.

In this study, the density and identity of oil-degrading bacteria in water and sediment of the north-western Arabian Gulf were evaluated in order to establish baseline information for this part of the Arabian Gulf.
Index terms: bacteria/biodegradation/fate of pollutants/oil pollution/ Persian Gulf/baseline studies/cleanup operatons/hydrocarbons/marine environment/oil spills

135. HANNA, R.G. M. (Red Sea Branch, Inst. Oeanography & Fisheries, Cairo, Egypt)
Oil pollution on the Egyptian Red Sea coast.
Marine Pollution Bulletin, vol. 14, p. 268, 1983.
Index terms: Pollution/Hydrocarbon/Crude oil/Red Sea/Egypt/Seawater/ Analytical determination/Concentration/Measurement result

136. HANNA, R.G., and G.L. MUIR (STATE POLLUTION CONTROL COMMISSION
OF NEWSOUTH, WALES, AUSTRALIA,)
RED SEA CORALS AS BIOMONITORS OF TRACE METAL POLLUTION.
ENV MONITORING & ASSESSMENT, vol. 14, no. 2-3, p. 211-223, MAY 90.

DESCRIBED IS THE APPLICABILITY OF CORAL FOR BIOMONITORING TRACE

METAL POLLUTION AND THE DISTRIBUTION PATTERNS OF TRACE METALS BETWEEN SKELETAL AND ORGANIC MATTER FROM CORAL SOFT TISSUE AND SKELETAL ORGANIC MATRIX IN ADDITION TO THE SPATIAL VARIATIONS BETWEEN AND WITHIN THE DIFFERENT SPECIES. SAMPLES OF THREE CORAL SPECIES- PORITES LUTES, GONIASTREA RETIFORMIA, AND POCILLOPORA VERRUCOSE-WERE COLLECTED FROM A POLLUTED AREA NEAR A DESALINATION PLANT AND FROM AN UNPOLLUTED AREA AT JEDDAH, SAUDI ARABIA, ON THE RED SEA. MONITORING RESULTS INDICATE THAT CORALS ACCUMULATE TRACE ELEMENTS FROM THEIR AQUATIC ENVIRONMENT AND THEREBY ACT TO RECORD CHANGES IN THE COMPOSITION OF THAT ENVIRONMENT. THE CORAL SPECIES WERE ANALYZED FOR VARIOUS TRACE METALS, INCLUDING CADMIUM, MERCURY, AND ZINC, IN BOTH SKELETAL AND SOFT TISSUES; CORALS IN POLLUTED WATERS HAD SIGNIFICANTLY HIGHER CONCENTRATIONS OF THESE ELEMENTS THAN THOSE IN NONPOLLUTED WATERS. (1 MAP, 20 REFERENCES, 7 TABLES)
Index terms: CORAL REEFS /BIOLOGICAL INDICATORS-MARINE /BIOACCUMULATION-ANIMAL/HEAVY METALS /MONITORING, ENV-MARINE /TRACE ELEMENTS /METAL CONCENTRATIONS /WATER POLLUTION RESEARCH /MARINE ECOSYSTEMS /AREA COMPARISONS /RED SEA /SPECIESCOMPARISONS /ENV QUALITY ASSESSMENT/MARINE POLLUTION

137. Hanna, Rifaat G.M. (State Pollut. Control Comm.; Sydney; 2001; Australia)
Levels of heavy metals in some Red Sea fish before hot brine pools mining.
Marine Polluttion Bulletin, vol. 20, no. 12, p. 631-5, 1989.
Index terms: seawater pollution heavy metal/heavy metal contamination fish seawater/brine pool mining pollution /Water pollution (by heavy metals, of seawater, hot brine pool mining in relation to, of Red Sea) /Fish (heavy metals in, hot brine pool mining and water pollution in relation to, of Red Sea) /Liver,composition/Muscle, composition/ Ovary,composition/Reproductive organ/Testis,composition (heavy metals in, of fish, hot brine pool mining and water pollution in relation to, of Red Sea) /Metals,heavy,biological studies (in fish, hot brine pool mining and water pollution in relation to, of Red Sea)

138. Hardy, J.T., and Z. Jubayli (Dept. of Biology, American Univ., Beirut, Lebanon)
Phytoplankton standing crop and sewage nutrient enrichment along the central coast of Lebanon.
Environmental Pollution, vol. 11, p. 195-202, 1976.

Surface nearshore water samples from seven stations along the central coast of Lebanon were analysed at different seasons for concentrations of nitrate, nitrite, ammonia, phosphate, and chlorophyll-a standing crop.
Index terms: primary productivity/biomass/standing crops/ phytoplankton/domestic wastes/sewage effluents/seasonal/chlorophyll/ ammona/nitrates/nitrites/phosphates/nutrients/productivity/sewage disposal/water pollution effects/environmental effects/nitrogen compounds/on-site data collections/sampling/Lebanon

139. Hebden, T.P. (Bahrain Petroleum Co. Ltd., Saudia Arabia)
Gulf area oil companies Mutual Aid Organization: inception, formation and operation.
Petroleum and the Marine Environment, 1981.

The Gulf Area Oil companies Mutual Aid Organization (GOACMAO) was formed to pool the resources of all member companies for joint capability to clean up oil spills, which are beyond the capability of a single party. Any member affected by an oil spill may call on other members of the Organization for assistance. The member requesting assistance shall reimburse other members for any costs they have borne providing this assistance. At the present time, the members of the

Organization are those companies operating on the Arabian side of the Gulf. Map (2) outlines the areas and the location of the companies. In many cases, through Government participation, companies have changed or amended their names since the formation of GAOCMAO in 1972. Experience during the last 8 years has shown that the need for a mutual aid organization in this part of the world was wellfounded. The quantity and variety of equipment and materials currently available to the Organization are a reflection of the progress made since that first exploratory meeting in Bahrain in 1971. In retrospect, the Organization has worked well and, on several occasions, has been put to the test when emergency situations have arisen. Contacts and communications are a vital component of the scheme. The first occasion when the Organization was called upon was not for oil spill clean up, but when a serious fire occurred in the BAPCO Refinery in Bahrain. Direct contact between GAOCMAO members was put to the test and enabled large quantities of firefighting equipment and materials to be mobilized and shipped to Bahrain in a short space of time. It tested the Contacts and communications of the Organization which so soon after its formation were not found wanting. This incident indicated that the vagueness of the title Mutual Aid Organization may well have advantages.|;
Index terms: OIL SPILLS -- EMERGENCY PLANS/PETROLEUM INDUSTRY -- COOPERATION /COMMUNICATIONS/FIRE FIGHTING/FIRES/PERSIAN GULF/POLLUTION CONTROL EQUIPMENT /ARABIAN SEA/EQUIPMENT/INDIAN

140. Hilmy, A.M.; M.B. Shabana, and M. Saied (Dep. Zool.; Alexandria Univ.; Alexandria; Egypt)
A comparative study of mercury poisoning on Aphanius dispar (Teleostei), Sergestes lucens (Crustacea), and Modiolus modiolus (Mollusca) of the Red Sea.
Comp. Biochem. Physiol. C, vol. 68C, no. 2, p. 199-204, 1981.
Index terms: mercury toxicity Aphanius Sergestes Modiolus /Water pollution (by mercury, marine animals in relation to) /Animal,marine/ Aphanius dispar/Modiolus modiolus/Sergestes lucens (mercury acute and subacute toxicity to)

141. HILMY, A.M.; M.B. SHABANA, and M.M. SAIED (DEP. ZOOL., FAC. SCI., ALEXANDRIA UNIV., ALEXANDRA, EGYPT)
IONIC REGULATION OF THE BLOOD IN THE CYPRINODONT APHANIUS-DISPAR UNDER THE EFFECT OF EXPERIMENTAL MERCURY POLLUTION.
WATER AIR SOIL POLLUT, 1982, p. 467-474.

The effects of short- and long-term Hg exposure on the ionic

regulation of the Red Sea harry, A. dispar, were studied. [In acutely treated fish, Na+, Ca2+ and K+ increased significantly. In the chronic group, this increase occurred subsequently. Mg2+ levels showed higher values in the acute case, but an adaptation occurred in the chronic case. Serum chloride displayed an inverse pattern throughout the experiment.]
Index terms: METAL POLLUTION

142. Hilmy, A.M.; M.B. Shabana, and M.M. Saied (Dep. Zool.; Alexandria Univ.; Alexandria; Egypt)
Mercury levels in some Red Sea marine pelagic and benzic food chain individuals and their biota.
Comp. Biochem. Physiol. C, vol. 68C, no. 2, p. 195-7, 1981.
Index terms: mercury Red Sea animal/food chain marine mercury /Water pollution (by mercury, of Red Sea, food chain in relation to) /Animal, marine/Aphanius dispar/Ecology, food-chain, marine/Geological sediments/Modiolus modiolus/Sergestes lucens (mercury of, of Red Sea)

143. Hoi-Chaw, L. and Meow-Chan, F. (editors)
Fate and effects of oil in the mangrove environment.
USA ; University Sains, Malaysia : Exxon Corporation, 1984.

144. Holusha, John
U.S. companies to join bid to minimize Gulf oil spill. (Persian Gulf) (International Pages) (War in the Gulf).
New York Times, Jan 29, 1991, v140 col 1, pA5(N) pA11(L).

145. Holusha, John
War's hazards for environment are assessed. (Persian Gulf War).
New York Times, Jan 24, 1991, v140 col 3, pC14(N) pD6(L).

146. HORNUNG, H., and G.J. RAMELOW (Israel Oceanographic Limnological Research, Inc., Haifa 31080, Israel)
Distribution of Cd, Cr, Cu, and Zn in eastern Mediterranean fishes.
Marine Pollution Bulletin, vol. 18, p. 45-49, 1987.
Index terms: Water pollution/Marine environment/Accumulation/Heavy metal/Cadmium/Chromium/Copper/Zinc/Mediterranean Sea/Pisces/Israel

147. Hulings, N.C. (Yarmouk University Marine Science Center, Aqaba, Jordan)
Uranium content of sediments from the Jordan Gulf of Aqaba.
Mar. Pollut. Bull. (United Kingdom), vol. 13, no. 2, Feb 1982.

The uranium content of nearshore sediments in the Jordan Gulf of Aqaba

has been determined. The concentrations are shown to vary according to sediment type or habitat in unpolluted areas, while in a polluted area the concentration is related to phosphate dust pollution.|;
Index terms: RED SEA -- SEDIMENTS/RED SEA -- WATER POLLUTION/SEDIMENTS -- CHEMICAL COMPOSITION/URANIUM -- ECOLOGICAL CONCENTRATION / ABUNDANCE/DUSTS/ENVIRONMENT/JORDAN/NATURAL OCCURRENCE/NATURAL URANIUM/ PHOSPHATE ROCKS/SHORES /ACTINIDES/ASIA/DEVELOPING COUNTRIES/ELEMENTS/ METALS/POLLUTION/ROCKS/SEAS/SEDIMENTARY ROCKS/SURFACE WATERS/URANIUM

148. Hulm, P.
The Regional Seas Program: what fate for UNEP's crown jewels.
Ambio, vol. 12, no. 1, p. 2-13, 1982.
An overview is offered of each of UNEP's 10 Regional Sea Programs.
Index terms: water pollution control/seawater/Atlantic Ocean/Pacific Ocean/Asian Ocean/Caribbean Sea/Red Sea/Gulf of Aden/Kuwait/ Mediterranean Sea/water management/administration/planning/ international waters/international commissions/international agreements

149. HUTCHINSON, T.C.; N.B. SNOW; RONALD EISLER; ROGERD. ANDERSON;
RICHARDF. LEE; CLAYTOND. MCAULIFFE, and GLENN. WILLIAMS
ENVIRONMENTAL EFFECTS OF OIL SPILLS: II.
PRESENTED AT EPA/API/USCG CONF ON PREVENTION & CONTROL OF OIL POLLUTION, SAN FRANCISCO, MAR 25-27, 1975, p. 517
(95)VARIOUS RESEARCH PROJECTS ON THE ENVIRONMENTAL EFFECTS OF OIL POLLUTION ARE DESCRIBED. TOPICS INCLUDE: EFFECTS OF EXPERIMENTAL CRUDE OIL SPILLS ON CANADIAN ARCTIC VEGETATION; EFFECT AND FATE OF CRUDE OIL SPILLED ON TWO ARCTIC LAKES; EFFECTS OF PETROLEUM ON RED SEA MACROFAUNA; PETROLEUM HYDROCARBONS AND OYSTERS IN GALVESTON BAY, TEX.; FATE OF PETROLEUM HYDROCARBONS IN MARINE ZOOPLANKTON; AN INVESTIGATION OF THE 1970 CHEVRON MAIN PASS BLOCK 41 OIL SPILL; PREDICTION OF THE FATE OF OIL IN THE MARINE ENVIRONMENT; LONG-TERM OIL SPILL EFECTS AT FALMOUTH, MASS.; EFFECTS OF THE BOONE CREEK, S.C., OIL SPILL; PERSISTENCE AND EFFECTS OF LIGHT FUEL OIL IN SOILS;FATE AND EFFECTS OF OIL ON AN ESTUARINE POND; BIODEGRADATION OF CRUDE OIL STUDIED BY COMPUTERIZED MASS SPECTROMETRY; AND DISTRIBUTION OF AROMATIC HYDROCARBONS IN WATER, SEDIMENT, AND ANIMAL TISSUES IN AN EXPERIMENTAL SHRIMP POND. (7 DIAGRAMS, 83 GRAPHS, 7 MAPS, 6 PHOTOS, 219 REFERENCES,

77 TABLES)
Index terms: OIL SPILLS /MARINE POLLUTION DAMAGE /HYDROCARBONS-WATER / TUNDRA/CANADA /ARCTIC WATERS /RED SEA /OYSTERS /ZOOPLANKTON / SHRIMP / BIODEGRADATION-MICROORGANISM /SOIL CONTAMINATION /SPECTROMETRY /EPA CONF PAPER

150. Ibragim, A.M.; S.A. Patin, and S.A. Sokolova (Vses. Nauchno-Issled. Inst. Morsk. Rybn. Khozyastv. Okeanogr.; Moscow; USSR)
Combined effect of some metals on phytoplankton photosynthesis in coastal waters of the Red Sea.
Okeanologiya (Moscow), vol. 20, no. 3, p. 459-62, 1980.

The results are presented of the 3-day multifactor experiments on the integral action of Hg, Pb, Cd, and Cu on the phytoplankton of the Red Sea (near Al-Ghadarka). Hg, Pb, and Cd at 10 mu.g.cntdot. 1-1 and Cd at 100 .mu.g.cntdot. 1-2 intensify or suppress primary production depending on the combination of factors and the duration of their action.
Index terms: metal seawater phytoplankton photosynthesis/mercury plankton photosynthesis/lead plankton photosynthesis/copper plankton photosynthesis/cadmium plankton photosynthesis /Photosynthesis (by phytoplankton, in Red Sea, trace metals effect on) /Water pollution (by trace metals, phytoplankton photosynthesis response to) /Plankton, phyto- (photosynthesis by, in Red Sea, trace metals effect on) / Metals,biological studies (phytoplankton photosynthesis response to, in Red Sea)

151. Ibragim, A.M., and S.A. Patin
Influence of mercury, lead, cadmium and copper on primary production and phytoplankton in some coastal areas of the Mediterranean and Red Seas.
Okeanologiya, vol. 15, no. 5, p. 886-890, 1975.
In Russian.

Series of short- and long-term experiments were made to evaluate the effect of Hg, Cu, Cd and Pb upon the production and specific composition of the coastal phytoplankton in the Mediterranean and Red Seas at in situ temperatures and light conditions. (The initial composition of the phytocenosis was mainly Nitschia closterium, Coscinodiscus granii, Rhizosolenia alota). The experiments showed a possibility of an essential change of photosynthetic rate and specific composition of phytoplankton natural communities under the action of the concentration of metals close to the natural level in the seawater. N. closterium was most stable to the effect of metals.

Index terms: cadmium/copper/lead/mercury/phytoplankton/primary productivity/light/coasts/oceans/temperature/water pollution effects/ metals/Coscinodiscus granii/Mediterranean Sea/Nitschia closterium/ Rhizosolenia alata/Red Sea

152. **Industry fears oil spill will affect oil supply.**
Japan Economic Newswire, Jan 26, 1991.

153. **Iran to demand damages from U.S. (for attack on oil platforms in Persian Gulf).**
Japan Economic Newswire, Oct 20, 1987.

154. **Iran attempting to control oil slick.**
Japan Economic Newswire, Jan 27, 1991.

155. **Iran seeks help to curb oil spill, Iraq blames U.N. chief. (Javier Perez de Ceullar).**
Japan Economic Newswire, Jan 27, 1991.

156. **Iraq tanker hit; causes oil spill in Persian Gulf. (Cover Story).**
Platt's Oilgram News, Jan 25, 1991, v69 n18, p1(2).
ARTICLE TYPE: Cover Story

157. Isikoff, Michael
Experts consider using chemicals to combat Gulf oil spill. (The Persian Gulf War).
Washington Post, Jan 29, 1991, v114 col 2, pA10.

158. Isikoff, Michael
Gulf oil spill said to be at least temporarily halted. (oil spill as result of Persian Gulf war) (The Persian Gulf War).
Washington Post, Jan 28, 1991, v114 col 1, pA14.

159. Isikoff, Michael
Saudis brace for onslaught of oil slick; water desalination plants on coast are threatened. (Persian Gulf War).
Washington Post, Jan 27, 1991, v114 col 1, pA22.

160. ISMAIL, N.S., and AWAD JAMAL (Marine Sci. Stn., Aqaba, Jordan)
Effects of sewage dumping on macrobenthic invertebrates in the Jordan Gulf of Aqaba, Red Sea.
Internationale Revue der Gesamten Hydrobiologie, vol. 72, no. 2, p. 225-234, 1987.

There are two sewage outfalls along the Jordanian coastline of the Gulf of Aqaba. During 1982 and 1983 a total of 328 core samples (0.01 sq m to a depth of 15 cm) were collected from the two outfalls, two control stations which resemble the outfalls in depth and sediment texture, and from two stations 100 m on both sides of each outfall. Faunal analysis revealed that the total number of individuals, number of species, species richness, and faunal similarities of macrobenthic invertebrates were lower at the sewage outfall near the phosphate loading port than the control station during both collections. At the 100 m stations, the numbers of individuals were generally higher than the sewage and control stations. The number of species, however, was highest at the control station and lowest at the sewage outfall. At the other sewage outfall, where the sewage effluent was discharged sporadically, no measurable effects on macrobenthic invertebrates were found.
Index terms: Zoobenthos/Waste water/Environment impact/Ecological abundance/Species diversity/Comparative study/Gulf of Aqaba/Water pollution/Marine environment/Invertebrata /Zoobenthos

161. IUCN.
Ecological guidelines for the use of natural resources in the Middle East and southwest Asia.
Gland, Switzerland : IUCN, 1976.
(IUCN publications new series ; no. 34)

162. IUCN.
IUCN Red List of threatened animals.
Gland, Switzerland ; Cambridge, UK : IUCN, 1990.
228 p.

163. IUCN.
Promotion of the establishment of marine parks and reserves in the northern Indian Ocean including the Red Sea and the Persian Gulf.
Gland, Switzerland : IUCN, 1976.
(IUCN publication new series ; no. 35)

164. IUCN.
Saudi Arabia: an assessment of biotopes and management requirements for the Saudi Arabian Gulf Coast.
Gland, Switzerland : IUCN, 1987.
Report prepared for MEPA by IUCN, Gland, Switzerland.

165. IUCN.
United Nations list of national parks and protected areas.

Gland, Switzerland ; Cambridge, UK : IUCN, 1990.
Prepared for IUCN by WCMC.

166. Jacobs, R.P. W.M.
Oil and the seagrass ecosytem of the Red Sea.
Oil and Chemical Pollution, vol. 5, no. 1, p. 21-?, 1989.
Index terms: oil pollution effect/spill-combat method/seagrass ecosystem/Red Sea

167. JAMAL, ABAYCHI, and H.T. AL-SAAD (Univ. Basrah, Marine Sci. Cent., Basrah, Iraq)
Trace elements in fish from the Arabian Gulf and the Shatt al-Arab River, Iraq.
Bulletin of Environmental Contamination and Toxicology, vol. 40, 1988.
Index terms: Metal/Trace element/Biological accumulation/Pisces/ Persian Gulf/Stream/Iraq/Water pollution/Marine environment/Freshwater environment/Edible fish

168. **Japan to send oil fence to Gulf. (Persian Gulf).**
Japan Economic Newswire, Jan 30, 1991.

169. Johnson, B., and W. Ofosu-Amaah (International Inst. for Environment and Development, Washington, DC.)
Legal, Regulatory and Institutional Aspects of Environmental and Natural Resources Management in Developing Countries: A Country Study of Sudan.
Washington, DC.; : Agency for International Development, National Park Service, May 82. 82 p.
Report #: AID-PN-AAN-846
Sponsored by National Park Service, Washington, DC.

Desertification, the negative health impact of irrigation programs, excessive pesticide and fertilizer use, aquatic weed infestation, wildlife depletion, and degradation of the Red Sea ecology are the major problems besetting Sudan's attempt to manage its vast natural and environmental resources. The legal, regulatory, and institutional aspects of that management effort are the subject of this report. Individual chapters are devoted to governmental structure and the legal system, attitudes towards law, natural resource and environmental policy, and Government of Sudan resource management entities. Major legislative provisions are discussed for 10 major resource sectors.
Index terms: Natural resources/Wildlife/Irrigation/Water pollution/Red Sea/ Government policies/Legislation/Ecology/Conflicts/Organizations/

Land use/Local government/Law enforcement/Environmental impacts/Sudan /Developing country application/Desertification

170. Karapetian, J.V., and A.M. Shahmoradi (Tehran Univ., Dept. of Toxicology, Tehran, Iran)
Arsenic concentrations in canned tuna fish and sediments.
Bull. of Environmental Contamination and Toxicology, vol. 20, p. 602-605, 1978.

Twenty samples of canned tuna fish from the Persian Gulf and ten samples of canned sardine from the Caspian Sea were collected. The range of arsenic concentrations in the tuna fish and sardine were 0.65-1.00 and 0.0-1.20 ppm and the means of the concentrations were 0.78 and 1.00 ppm, respectively.
Index terms: public health/heavy metals/arsenic compounds/arsenic/ tuna/sardins/Caspian Sea/Persian Gulf/chemical analysis/commercial fishing/hazards/spectrophotometry/path of pollutants/water pollution effects/foods/food processing/industry/water quality standards/tissue analysis

171. KECKES, S.
THE REGIONAL SEAS PROGRAMME OF UNEP,.
INDUSTRY & ENV, JUL-SEP 80, p. 5-8.
Report #: vol. 3, no. 3.

ALTHOUGH THE ENVIRONMENTAL PROBLEMS OF THE OCEAN ARE GLOBAL IN SCOPE, THE DIRECTORS OF THE U.N. ENVIRONMENTAL PROGRAMME DECIDED THAT IT WOULD BE MORE REALISTIC TO ADOPT A REGIONAL APPROACH TO SOLVING THESE PROBLEMS. TWO ELEMENTS ARE FUNDAMENTAL TO THE U.N. ENVIRONMENTAL PROGRAMME'S REGIONAL SEAS PROGRAM: COOPERATION WITH THE GOVERNMENTS OF THE SPECIFIC REGIONS TARGETED FOR A PARTICULAR PROGRAM; AND COORDINATION OF THE TECHNICAL WORK THROUGH THE U.N. SYSTEM. REGIONAL PROGRAMS UNDERTAKEN IN THE SOUTHWEST PACIFIC, WEST AFRICA, RED SEA AND GULF OF ADEN, EAST ASIA, SOUTHEAST PACIFIC, EAST AFRICA AND SOUTHWEST ATLANTIC, KUWAIT, AND MEDITERRANEAN REGIONS ARE DESCRIBED. (1 MAP)
Index terms: MARINE POLLUTION CONTROL /U N ENV PROGRAMME /ENVIMPACT ASSESSMENT/ENV MANAGEMENT, INTL /AREA COMPARISONS /MEDITERRANEAN SEA / RED SEA/WEST AFRICA /ASIA /KUWAIT

172. Keckes, S. (United Nations Environment Program, Geneva, Switzerland)

UNEP regional seas program.
Petroleum and the marine environment, 1981.

Although the environmental problems of the ocean are global in scope, a regional approach to solving them seemed more realistic. By adopting a regional approach, UNEP felt it could focus on specific problems of high priority to the states of a given region thereby more readily responding to the needs of the governments and helping to mobilize more fully their own national resources. It was thought that undertaking activities of common interest to coastal states on a regional basis should, in due time, provide the basis for dealing effectively with the environmental problems of the oceans as a whole. Two elements are fundamental to the Regional Seas Program: (a) co-operation with the governments of the regions; and (b) co-ordination of the technical work through the United Nations system. At present there are eight regional seas areas where action plans are operative or are under development: the Mediterranean (adopted in 1975), the Red Sea (adopted in 1976), the Kuwait Action Plan Region (adopted in 1978), the Wider Caribbean Region (adoption expected in 1980), the West African Region (adoption expected in 1981), the East Asian Seas (adoption expected in 1981), the South-East Pacific (adoption expected in 1981) and the South-West Pacific (adoption expected in 1981). The following is a brief review of the recent progress in each of the eight regional seas.|;
Index terms: OIL SPILLS -- EMERGENCY PLANS/OIL SPILLS -- REGIONAL ANALYSIS/OIL SPILLS -- WATER POLLUTION CONTROL/UNITED NATIONS

173. KECKES, STEPAN
UNEP REGIONAL SEAS PROGRAMME.
PRESENTED AT EUROCEAN PETROLEUM & MARINE ENV CONF, MONACO. 1980, p. 387(17).
THE U.N. ENVIRONMENT PROGRAM REGIONAL SEAS PROGRAM AIMS TO DEVELOP POTENTIAL SOLUTIONS TO THE COMPLEX ENVIRONMENTAL PROBLEMS OF THE OCEANS. BY ADOPTING A REGIONAL APPROACH, THE UNEP CAN FOCUS ON SPECIFIC PROBLEMS OF HIGH PRIORITY TO THE STATES OF A GIVEN REGION, THEREBY MORE READILY RESPONDING TO THE NEEDS OF THE INDIVIDUAL GOVERNMENTS AND HELPING TO MOBILIZE MORE FULLY THEIR OWN NATIONAL RESOURCES. COOPERATION WITH THE GOVERNMENTS OF THE EACH REGION, AND COORDINATION OF THE TECHNICAL WORK THROUGH THE U.N. SYSTEM ARE FUNDAMENTAL TO THE PROGRAM. THE COMPONENTS OF A REGIONAL PROGRAM ARE OUTLINED IN AN ACTION PLAN THAT IS FORMALLY ADOPTED BY THE GOVERNMENTS BEFORE THE PROGRAM BECOMES OPERATIVE. EACH ACTION PLAN CONSISTS OF AN

ENVIRONMENTAL ASSESSMENT, A RANGE OF ENVIRONMENTAL MANAGEMENT ACTIVITIES, AND SUPPORTING MEASURES. THERE ARE PRESENTLY EIGHT REGIONAL AREAS WHERE ACTION PLANS ARE OPERATIVE OR ARE UNDER DEVELOPMENT. (1 MAP)
Index terms: U N ENV PROGRAMME /MARINE POLLUTION CONTROL /AREA COMPARISONS / ENV IMPACT ASSESSMENT /MEDITERRANEAN SEA /RED SEA / KUWAIT / AFRICA /CARIBBEAN SEA /ENV MANAGEMENT, INTL /CONF PAPER

174. KENFIELD, JON (TWICKENHAM TRAVEL, LONDON, ENGLAND)
UNDER THE RED SEA.
WILDLIFE, MAY 1978, vol. 20, no. 5, p. 220-227.

THE GULF OF EILAT, THE GULF OF AQABA, AND THE RED SEA ALL REFER TO THE NARROW STRIP OF WATER NEATLY DIVIDING JORDAN AND SAUDI ARABIA FROM ISRAEL. THE GOVERNMENT OF ISRAEL, ACTING THROUGH MILITARY AUTHORITIES, HAS DECLARED THAT ALMOST THE ENTIRE COAST IS A NATURE RESERVE. BUT SO-CALLED DIVER POLLUTION HAS AFFECTED SOME OF THE MOST ACCESSIBLE AND WELL-KNOWN SITES IN THE RED SEA, AND TO DATE IN 1978 THERE HAVE BEEN TWO HUGE OIL SPILLS FROM A PORT JUST OUTSIDE EILAT. (10 PHOTOS)
Index terms: RED SEA /MARINE POLLUTION DAMAGE /TOURISM /CORAL REEFS / OIL SPILL INCIDENTS /OIL SPILL CLEANUP /DESERT ECOSYSTEMS

175. KETCHUM, Bostwick H. (Woods Hole Oceanogr. Inst., Woods Hole, MA)
Enclosed seas; introduction.
Ecosyst. World, vol. 26, 1983.
Index terms: Black Sea/Red Sea/Baltic Sea/Bering Sea/Okhotsk Sea/Japan Sea/East China Sea/Gulf of Saint Lawrence/Gulf of California/Human activity/Pollution/Ecology/Salinity/Marine geology/Marginal seas/ Estuaries/Marine environment/Estuarine environment/Enclosed seas

176. Ketchum, B.H. (c/o Woods Hole Oceanogr. Inst., Woods Hole, MA 02543, USA)
Estuaries and enclosed seas.
ECOSYSTEMS OF THE WORLD.
AMSTERDAM (NETHERLANDS) : ELSEVIER SCIENTIFIC, 1983.

At any given place within an estuary the salinity can vary widely on several time scales. The geographical extent and the magnitude of these changes are largely determined by the unique geomorphology of each estuary, but all estuaries are characterized by an extremely variable set of environmental conditions. Section 1 of this volume consists of seven chapters which discuss these variations and their

effects on the resident populations of marine or brackishwater species. The characteristics of ten enclosed seas are discussed in section 2 of this volume. Each of these enclosed seas is connected with the open ocean in a way which controls and modifies the circulation within the sea and produces an environment and an ecosystem which is unique and different from the adjacent coastal waters. The enclosed seas discussed include the European Mediterranean Sea, the Black Sea, the Red Sea, the Baltic Sea, the Bering Sea, the Okhotsk Sea, the Japan Sea, the East China Sea, the Gulf of St. Lawrence, and the Gulf of California. Most of these seas are brackish and illustrate on a large scale typical estuarine characteristics and processes.
Index terms: estuaries/physicochemical properties/marine pollution/ books/fisheries/resource management

177. KHALAF, F.; V. ANDERLINI, and P. LITHERATHY
Vanadium as a tracer of chronic oil pollution in the sediments of Kuwait.
Annual research report-Kuwait Institute for Scientific Research, 1981.
Index terms: Metals/Vanadium/Tracers/Pollution/Petroleum/Marine sediments/Sand/Kuwait/Persian Gulf

178. KLAUSEWITZ, W., and M. TUERKAY
STUDIES ON THE DEEP SEA BENTHOS OF THE RED SEA.
NAT MUS, 1981, p. 24-25.
Index terms: FISH/LOBSTER/ANIMAL/SEDIMENT/CHEMISTRY/HEAVY METAL POLLUTION

179. Kolton-Shapira, R.; Y. Lakritz, and M. Luria (Hadera Association of Towns for Environmental Protection, Israel)
Rainwater pH in the vicinity of Hadera Power Plant, Israel during the winter season of 1981-1982.
Atmospheric Environment, vol. 18, no. 6, p. 1245-1248, 1984.

A new method for the continuous pH measurement of rainwater is discussed. The method, applied at site near a new coal-fired power plant (prior to its operation) showed a pH variation of 4.3 to 9.2 as compared to 6.5 observed using conventional methods which measure pH at the end of each rain episode. The alkalinity of top soil in the vicinity, and hence natural aerosols act as a buffer, reducing the acidity of the rain. This buffering effect disappears after 30-40 mm of rainfall. A pH of more than 7.5 was noted at the early stages of rainfall. After 30-40 mm of rain, the pH decreased to less than 5.6. A complete washout of the atmosphere varied with the aerosol mass load

and the time period between rain events. In six of the 22 rain episodes recorded, a pH lower than 5.6 was noted for anthropogenic reasons. During the night, winds tend to blow westward, so pollutants from the coastal sources are transported towards the sea. The daytime flow pattern is nearly reversed. As the sun rises, this air is transported eastward and photooxidizes. Sulfur dioxide and nitrogen oxides are converted to acid aerosols over the Eastern Mediterranean Sea. When the return of this air parcel coincides with a rain storm, these acid aerosols are washed from the air. Only partial information is provided by measuring bulk quantities of the rain after each precipitation period. The detection of the extreme pH levels which exist is only possible by continuous monitoring using the flow system as described.
Index terms: acid rain/precipitation chemistry/Israel/Hadera/hydrogen ion concentration/sulfur dioxides/nitrogen oxides/powerplants/soil alkalinity/buffering/water pollution sources

180. Kuwait Institute for Scientific Research.
Criteria for development and management of Kuwait's first national park/nature reserve.
Safat, Kuwait : The Institute, 1986.

181. **Kuwaiti envoy slams Hussein for oil spill. (Abdul-Aziz Abdullah Al-Sharekh, Saddam Hussein).**
Japan Economic Newswire, Jan 28, 1991.

182. Lacayo, Richard
A war against the earth: torching oil wells and disgorging crude into the gulf, Saddam makes the planet his latest victim. (The Gulf War) (Cover Story).
Time, Feb 4, 1991, v137 n5, p32(2).
ARTICLE TYPE: Cover Story

183. Lange, J.; Trudinger, P.A.; Walter, M.R., and Ralph, B.J. (Mar. Technol. Dep.; Preussag A.-G.; Hannover; Fed. Rep. Ger.)
Control of environmental pollution by mining wastes (metalliferous muds, Red Sea).
Biogeochem. Ancient Mod. Environ., Proc. Int. Symp., 4th,. Canberra, Australia : Aust. Acad. Sci., 1980. p. 689-692.
Index terms: review mining waste environment pollution /Environment (pollution of, by mining waste, control of) /Mines (waste from, environmental pollution by, control of)

184. LARDNER, RW; HM CEKIRGE; AH AL-RABEH, and N. GUNAY (Simon

Fraser Univ., Dep. Math., Burnaby BC, Canada)
Passive pollutant transport in the Arabian Gulf.
Advances in Water Resources, vol. 11, 1988.
Index terms: Mathematical models/Convection/Diffusion/Oil spills/
Persian Gulf/Mathematical model

185. Leal, Donald R.
The Gulf isn't dead. (oil spill in Persian Gulf) (column).
New York Times, Feb 9, 1991, v140 col 2, p15(N) p23(L).
ARTICLE TYPE: column

186. Lee, Patrick
Oil well fires a challenge to experts. (fires at Kuwaiti oil facilities can cause economic and environmental havoc in Persian Gulf War and be difficult to extinguish) (The Gulf War).
Los Angeles Times, Jan 23, 1991, v110 col 3, pA6.

187. LeGore, R.S.; J.E. Cuddeback; J.E. Hofmann, and D.S. Marszalek (Environmental Science and Engineering Inc.)
A field experiment to assess impact of chemically dispersed oil on Arabian Gulf corals.
Soc. Pet. Eng. AIME, Pap. (United States). 3. Middle East oil exibition, SPE 11444 Mar 1983.
Field experiments were conducted on a coral reef at Jurayd Island (Saudi Arabia) in the Arabian Gulf to study the effects of chemically dispersed oil on local corals. Portions of the reef were exposed to predetermined concentrations of oil alone, dispersant alone, and oil-plus-dispersant mixtures. Areas of the reef not exposed to any of the toxicants were used as controls. Arabian Light Crude and Corexit 9527 dispersant were the test toxicants. Two series of experiments were conducted beginning in September 1981, one with a 24-hour exposure period and the other with a 5-day (120-hour) exposure period. Corals were stained for growth rate studies and extensively photographed to document any observed effects. Corals were examined for biological impacts immediately after the exposures, and then at 3-month intervals for 1 year. Water temperature, salinity, dissolved oxygen, and hydrocarbon content were recorded during the exposure periods. Coral growth appeared unaffected by exposure to the toxicants. Some Acropora species corals exposed to dispersed oil for 5 days exhibited delayed effects, which became apparent during the relatively cold winter season.
Index terms: OIL SPILLS -- ENVIRONMENTAL EFFECTS/OIL SPILLS -- FIELD TESTS/PERSIAN GULF -- CORALS/PERSIAN GULF -- REEFS /DISPERSIONS/ DISSOLVED

GASES/HYDROCARBONS/MONITORING/OXYGEN/PETROLEUM/PHOTOGRAPH
Y/
SALINITY/SAUDI ARABIA/SEASONAL VARIATIONS/
SEAWATER/TEMPERATURE DEPENDENCE/TIME DEPENDENCE /ARABIAN
SEA/ASIA/CNIDARIA/ELEMENTS/ENERGY SOURCES/ FLUIDS/FOSSIL
FUELS/FUELS/GASES/GEOLOGIC STRUCTURES/HYDROGEN
COMPOUNDS/INDIAN OCEAN/NONMETALS/ORGANIC COMPOUNDS/OXYGEN
COMPOUNDS /SEAS/SOLUTES/SURFACE
WATERS/TESTING/VARIATIONS/WATER

188. Lehr, W.J., and M.S. Belen (Univ. of Petroleum and Minerals, Dhahran)
The fate of two large oil spills in the Arabian Gulf.
American Petroleum Institute conference on oil spill, Feb 1983.

In August and October 1980, two large oil spills occurred in the Arabian Gulf. The first, from an unidentified source, involved about 20,000 barrels of crude oil and impacted the entire north and west coasts of the island nation of Bahrain. The second occurred when the Ron Tapmeyer platform in the Hasbah offshore oil field blew out, releasing an estimated 50,000 barrels of thick crude into the Gulf. The spill subsequently covered large sections of the coastline of Qatar. The fate of the oil from these spills is examined with respect to the unique conditions found in the region. A computer model is used for trajectory analysis of the spills and hypothesizing the possible origin of the first spill. Methods of cleanup and problems with the weathered oil are mentioned. The environmental damage caused by the Bahrain spill is assessed.
Index terms: OIL SPILLS -- ENVIRONMENTAL EFFECTS/OIL SPILLS -- PATTERN RECOGNITION/OIL SPILLS -- WATER POLLUTION CONTROL/PERSIAN GULF -- OIL SPILLS
/BAHRAIN/BLOWOUTS/COMPUTERIZED SIMULATION/OIL WELLS/QATAR / ACCIDENTS/ARABIAN SEA/ASIA/CONTROL/INDIAN OCEAN/ MIDDLE EAST/POLLUTION CONTROL/SEAS/SIMULATION/SURFACE WATERS/WELLS

189. Lehr, W.J., and H.M. Cekirge (Univ. of Petroleum and Minerals, Dhahran, Saudi Arabia)
Oil slick movements in the Arabian Gulf.
Petroleum and the marine environment, p. 737-741, 1981.
Published by Graham & Trotman, London.

As the world center of the oil industry, the Gulf region faces a high potential danger for oil pollution. One factor in the location assignment of oil pollution control task forces is the assessment of the danger of contamination for various shorelines on the Gulf.

Therefore, the authors have constructed a model for estimating the trajectory of oil spills for various locations in the Gulf based upon seasonal average climatic data. While chiefly of use for statistical conclusions, our model could be used by oil spill detection agencies to provide an expected spill path on the basis of minimal information about such a spill. Such a first guess trajectory would, for example, help assess governmental responsibility for clean-up in the region with its multinational coastline. It could also determine whether such a spill is likely to come ashore in any area where it could do severe damage and hence must be further monitored and controlledor whether only minimal risk is involved and less urgent response required. Assuming no prior preference for any site in the Gulf as an oil spill origin, it was possible to determine those coastal areas which have a high risk for oil pollution. The Southern Iranian coastline has the highest danger for oil pollution although the Emirate coasts also show considerable risk potential. The other coasts are relatively safe except for the Southern Arabia and Qatar region which shows high risk for oil drifts in the summer and fall. Northern Arabia, while fairly safe from spills, has its greatest pollution risk season in the spring. This may suggest that any oil spill task force for Saudi Arabia be stationed in the north during the first part of the year and moved south for the summer and fall.
Index terms: OIL SPILLS -- TRAJECTORIES /CONTAMINATION/FORECASTING/ MATHEMATICAL MODELS/PERSIAN GULF/SHORES/ SPATIAL DISTRIBUTION /ARABIAN
SEA/DISTRIBUTION/INDIAN OCEAN/SEAS/SURFACE WATERS

190. Lemonick, Michael D.
Dead sea in the making: a fragile ecosystem brimming with life is headed for destruction. (The Gulf War) (Cover Story).
Time, Feb 11, 1991, v137 n6, p40(2).
ARTICLE TYPE: Cover Story

191. Linden, O. (Swedish Water and Air Pollution Research Lab., Goeteborg)
Biological Impact and Effects on Fisheries of Oil Spill in Bahrain, August - September 1980.
Mar 1981. 26 p.
Report #: DE82-901433; IVL-B-607 Available from NTIS.

The report was presented at the IMCO/UNEP International Workshop on Combating Marine Pollution from Oil Exploration, Exploitation, and Transport in the Kuwait Action Plan Region, held in Manama, Bahrain, 6 - 10 December 1980. It was prepared under the terms of an IMCO/FAO

Advisory Mission to Bahrain which took place following a major oil spill affecting the coast of the country in August-September 1980. Conclusions are arrived at concerning the biological impact of the spill and the effect of the spill on fisheries: the first being mainly the mortality of marine life as a result of smothering of organisms by residual oil in and above the inter-tidal zone and the effect due to the destruction of fishing equipment and the prevention of fishing during the acute phase of the spill. The report lists the recommendations to the Bahrain Government concerning restrictions on the use of dispersants in shallow water and the need to avoid removal and replacement of oil contaminated sediments unless such oil was likely to re-contaminate sections of the beach reserved for recreational use or fishing-related activities.
Index terms: Persian gulf/Oil spills/Offshore operations/Fishing industry/Bahrain/Coastal waters/Surfactants/Environmental impacts/ Exploration/ Exploitation/Petroleum deposits/Recommendations /Foreign technology

192. LINDEN, O.; U. LARSSON, and ALAWIZ. S. AL (Swedish Environ. Res. Inst., Stockholm, Sweden)
Effects of chronic oil pollution in a shallow sub-tropical marine environment.
Oil & Chemical Pollution, vol. 5, p. 65, 1989.
Index terms: Environment/Water pollution/Seawater/Refinery/ Environmental protection/Fauna/Hydrocarbon/Persian Gulf

193. Lippman, Thomas W.; Booth, William
Oil spreading off Kuwait poses ecological disaster. (The Persian Gulf War).
Washington Post, Jan 26, 1991, v114 col 1, pA13.

194. **Long Gulf war could damage environment. (Persian Gulf War, 1991-).**
Japan Economic Newswire, Jan 25, 1991.

195. Le Lourd, P. (Regional Oil Combating Center for the Mediterranean, Manoel Island, Malta)
Oil pollution in the Mediterranean Sea.
AMBIO; A JOURNAL OF THE HUMAN ENVIRONMENT, RESEARCH AND MANAGEMENT, vol. 6, no. 6, 1977.

Chronic oil pollution is far more important than accidental pollution in the Mediterranean. The Load on Top procedure for reducing oil pollution of ballast water requires longer voyages than are typical of Mediterranean tanker operations. Only about half the 17 loading

terminals in the Mediterranean have reception facilities for oily ballast, so many ships discharge oily ballast in the 2 permissible zones which are K100 mi from land. The amount of oil entering the Mediterranean each year is 0.5-1 million T, or N25% of total world ocean oil pollution. The particular topography and hydrometeorological conditions of the Mediterranean are such that oil entering or discharged has little chance of leaving. Some countries have reported negative effects on some fish species. Oil pollution affects the northern Mediterranean countries on a regional basis, not only along the shores but even in the open sea. Due to the scarcity of nutrients and poor production of primary organisms, the Mediterranean marine environment takes a relatively long time to recover from contamination; the problem is worst in the eastern Mediterranean. Dispersants used to clean up oil spills must be carefully chosen as to their toxicity and the locations where they are to be used. Israel, Italy, and Spain have national contingency plans for combating accidental oil spills. UNEP is sponsoring a project to monitor baseline levels of oil and petroleum hydrocarbons, and coastal transport of pollutants. Protocols adopted at the Barcelona Conference deal with dumping by ships and aircraft and with cooperation in combating oil pollution. Oil pollution should begin to diminish in 1978 when the 1969 amendments to the 1954 Convention come into force. FT
Index terms: International agencies/International agreements/ International cooperation/Mediterranean Sea/Oil pollution control/ Oil pollution/Oil spills /UNEP

196. LOYA, Y. (DEP. ZOOL., GEORGE S. WISE FAC. LIFE SCI., TEL AVIV UNIV., TEL AVIV, ISRAEL)
EFFECTS OF MAN-MADE VERSUS NATURAL DISTURBANCES ON CORAL COMMUNITIES AT EILAT RED SEA.
MAB/COMAR (MAN AND BIOSPHERE PROGRAMME/COASTAL MARINE PROGRAMME) MICE (MAN'S IMPACT ON THE COASTAL AND ESTUARINE ECOSYSTEMS) IV MEETING: ASIAN AND PACIFIC REGIONAL WORKSHOP AND INTERNATIONAL SYMPOSIUM ON THE CONSERVATION AND MANAGEMENT OF CORAL REEF AND MANGROVE ECOSYSTEMS.1988. p. 325.
Index terms: HERMATYPIC CORAL/OIL POLLUTION/RECOLONIZATION

197. Loya, Y.
Possible effects of water pollution on the community structure of Red Sea corals.
Marine Biology, vol. 29, no. 2, p. 175-?, 1975.
Index terms: community structure/coral/Red Sea/water pollution

(possible effects)

198. LOYA, Y.
RE COLONIZATION OF RED SEA CORALS AFFECTED BY NATURAL CATASTROPHES AND MAN MADE PERTURBATIONS.
ECOLOGY, 1976, p. 278-289.

The recovery patterns of hermatypic corals following an unpredicted catastrophic low tide were studied on 2 reef flats in the northern Gulf of Eilat, Red Sea: the nature reserve of Eilat, Israel which is chronically polluted and a control reef which is pollution-free. The coral community structure and species diversity in both reefs were studied in 1969 and served as a base line for comparing the extent of mortality during the low tide (1970) and the extent of recovery 3 yr later. In 1969 no significant differences were found ($P > 0.05$) between the coral community structure of the nature reserve and the control reef when the average number of species, number of colonies, living coverage and diversity (H's) per transect were taken into account. During the low tide both reefs suffered mass mortalities of corals (85% at the nature reserve and 81% at the control reef). Although the extent of mortality in both reefs did not differ significantly ($P > 0.05$), a marked difference was observed in their recovery 3 yr later. The extent of coral recolonization was 23.times. greater at the control reef, but no significant difference ($P > 0.05$) was found in the extent of coral community regeneration in either place (15% at the nature reserve and 19.2% at the control reef). While the number of colonies, number of species, living coverage and H's are drastically decreased at the nature reserve 3 yr after the catastrophic low tide, the control reef exhibited an outstanding fast recovery (full recovery is expected 5-6 yr from the low tide). The commonest species on the control reef in 1969 showed the highest rates of recruitment in 1973, which might indicate the opportunistic life history of these species. One of the differences between man-made polluting activities and natural catastrophes on coral reefs is the possibility that the human-perturbed environment will not return to its former configuration, while reconstitution of reef areas denuded by natural disturbances is mainly a function of time. The higher coral diversity recorded on the control reef in 1973 (H's = 2.403) as compared to 1969 (H's = 2.206) may reflect a succession pattern in which diversity continues to increase in time after a catastrophe, until space becomes limiting and competitive interactions between species cause a decline in diversity. The unpredictable and extremely low tides at the Gulf of Eilat seem to interfere with this scheme and prevent monopolization of the reef flat by competitively

superior species. Catastrophic low tides probably act as an important diversifying force on the reef flats of Eilat, in a way similar to other biological and physical disturbances affecting coral communities.
Index terms:HERMATYPICCORAL/ISRAEL/POLLUTION/OPPORTUNISM/DIVERSITY/SUCCESSION

199. Loya, Y., and B. Rinkevich (Tel Aviv Univ., George S. Wise Center for Life Sciences, Dept. of Zoology, Tel Aviv, Israel)
Abortion effect in corals induced by oil pollution.
MARINE ECOLOGY; PROGRESS SERIES, vol. 1, no. 1, p. 77-80, 1979.

Sublethal concentrations of Iranian crude oil induce immediate mouth-opening in the Red Sea coral Stylophora pistillata, followed by premature extrusion of planulae larvae. Laboratory experiments with different concentrations of WSF of Iranian crude oil (0.1-10.0 m/L), showed that the average number of planulae extruded in each oil concentration was significantly higher than in the control. In natural conditions S. pistillata sheds its planulae only during the night. In presence of WSF of crude oil, shedding is immediate, day or night. Shedding of planulae during an oil spill decreases their viability and chances of successful settlement. In chronically oil-polluted reefs, i.e., the coral nature reserve of Eliat, almost no colonization of new coral colonies occurs, while high colonization is evident in reef areas free of oil pollution. AM
Index terms: Oil pollution/Marine organisms/Reproductive pathology/ Coelenterata/ Larvae /Iranian crude oil/corals/stylophora pistillata/ abortion effect

200. Loya, Y. and Rinkevich, B.
Effects of petroleum hydrocarbons on corals.
Salvat, B. (editor)
Human impacts on coral reefs: facts and recommendations.
French Polynesia : Antenne de Tahiti Museum, 1987. 253 p.

201. LUNDBERG, B., and Y. LIPKIN (DEP. BOT., HEB. UNIV., JERUSALEM, ISR.)
NATURAL FOOD OF THE HERBIVOROUS RABBITFISH SIGANUS-SPP IN NORTHERN RED SEA.
BOT MAR, 1979, p. 173-182.

The contents of stomach and intestines of specimens of S. rivulatus, S. luridus and S. argenteus from the Gulf of Elat were analyzed. The

percentage of each algal and seagrass species in the diet of the fish was determined. The diet of Siganus spp. was more diverse in the southern part of the Gulf than in the northern part. Near Elat the diet reflected the pollution-affected vegetation of the region. S. luridus grazed chiefly brown algae, whereas S. rivulatus and S. argenteus grazed substantial amounts of red and green algae as well. The composition of the diet in 2 stations was compared to that of the vegetation to determine the possible preferences of the fish. A few red algae, e.g., Champia irregularis, were selected by all the 3 Siganus spp. S. luridus selected Sargassum spp., Lobophora variegata and Cystoseira myrica, which were avoided by S. rivulatus and S. argenteus. Galaxaura spp. and Halophila stipulacea were selected by S. argenteus, but they were avoided by the other siganids.
Index terms: SIGANUS-RIVULATUS/SIGANUS-LURIDUS/SIGANUS-ARGENTEUS/

SARGASSUM-SPP/
LOBOPHORA-VARIEGATA/CYSTOSEIRA-MYRICA/CHAMPIA-IRREGULARIS GALAXAURA-SPP/ HALOPHILA-STIPULACEA/RED ALGAE/GREEN
ALGAE/BROWN ALGAE/SEAGRASS/INTESTINE/STOMACH/POLLUTION

202. Lynagh, N. (Energy Science & Technology file 103 Noble Denton and Assocs. Ltd.)
Environmental factors affecting the movement and dispersal of oil spills with particular reference to the gulf.
Soc. Pet. Eng. AIME, Pap. (United States), SPE13688 Mar 1985.

Currents, tidal streams and winds all influence the movement and dispersal of oil spills. Examination of the surface circulation and wind climate of the Gulf highlights the coasts most likely to be at risk of pollution by spills from the major offshore production areas. Methods used in forecasting movement of spills are discussed.
Index terms: OIL SPILLS -- PATTERN RECOGNITION /FORECASTING/PERSIAN GULF/TIDE/WATER CURRENTS/WATER POLLUTION ABATEMENT/WIND /ARABIAN SEA/
CURRENTS/INDIAN OCEAN/POLLUTION ABATEMENT/SEAS/SURFACE WATERS

203. MAMANE, Y.; E. GANOR, and A.E. DONAGI (Environmental Eng., Haifa 32000, Israel)
Aerosol composition of urban and desert origin in the Eastern Mediterranean. II: Deposition of large particles.
Water Air Soil Pollut, vol. 18, p. 475-485, 1982.

Monthly dust fall samples collected in 16 sites in the Tel-Aviv, Israel, Metropolitan Area, as well as those collected in 10 rural sites were analyzed for their physical properties and chemical content. The southwest part of Israel, which is scarcely populated, suffers from high dustfall values due to dust storms blowing from arid lands to the East Mediterranean during Spring. On an annual basis the natural dustfall of dust storm origin amounts to 25-30% of the Tel-Aviv area residential area deposition.
Index terms: Atmospheric pollutant deposition/Israel/Desert/Dust fall/ Heavy metals/Physical properties/Measurement result/Ambient air measurement/Aerosol settling

204. **Manifolds: pressure points for stemming the spill. (oil pipes targeted to be bombed to fight oil spill in Persian Gulf) (International Pages) (War in the Gulf).**
New York Times, Jan 28, 1991, v140 col 1, pA5(N) pA9(L).

205. **Marine Protection Quality.**
ISRAEL ENVIRON. BULL, 1981, p. 5-7.

Although it covers less than 1% of the world's total area of oceans, over 35% of the world's oil passes through the Mediterranean Sea. Crude oil and its derivatives are among the worst pollutants entering the Mediterranean. Yet of the 19 major oil terminals in the Mediterranean only 9 have adequate facilities where oil is separated and recycled - among these are Israel's Haifa and Ashkelon ports. Reception facilities for oily bilge and ballast exist in all of Israel's ports. Israel's coastline - both along the Mediterranean and the Red Sea - are among the coutry's most valuable environmental assets. Over two-thirds of the country's population and its industrial and commercial activity are centered with in 25 kilometers of the Mediterranean coastline. Protection of the region from the adverse effects of oil pollution is of high priority for the continuation of recreation and tourism as well as industrial development along the coast.
Index terms: marine pollution/environmental protection/oil spills/ Mediterranean Sea/pollutant dispersion

206. McCain, J.C. ; Tarr, A.B. ; Carpenter, K.E. and Coles, S.L.
Marine ecology of Saudi Arabia: a survey of coral reefs and reef fishes in the Northern Area, Arabian Gulf, Saudi Arabia.
Fauna of Saudi Arabia, vol. 6, p. 102-106, 1984.

207. MCCOY, F.W. (Columbia Univ. Palisades, Lamont-Doherty Geological

Obs. NY)
Floating megalitter in the eastern Mediterranean.
Marine Pollution Bulletin, vol. 19, p. 25, 1988.
Index terms: Water pollution/Mediterranean Sea/Debris/Content/Check/ Plastics/Floating body

208. McFadden, Robert D.
Oil threatens fishing and water supply. (oil slick brought on by Persian Gulf war).
New York Times, Jan 26, 1991, v140 col 3, p1(N) p1(L).

209. MERGNER, H. (RUHR-UNIV. BOCHUM, LEHRSTUHL SPEZIELLE ZOOL., D-4630 BOCHUM, FRG.)
THE ECOLOGICAL RESEARCH ON CORAL REEFS OF THE RED SEA.
MABAHISS/JOHN MURRAY INTERNATIONAL SYMPOSIUM ON MARINE SCIENCE OF THE NORTH-WEST INDIAN OCEAN AND ADJACENT WATERS, 1984, p. 855-884.
Index terms: CORALS/SESSILE/ANIMALS/ALGAE/SPONGES/MOLLUSKS/ ECHINODERMS/FISH/POLLUTION/CONSERVATION

210. Mesmar, M.N. (Dep. Biol. Sci.; Yarmouk Univ.; Irbid; Jordan)
Levels of zinc, cadmium and lead in some marine algae from Aqaba-Red Sea.
Acta Biol. Hung., vol. 39, no. 4, p. 345-9, 1988.

Jordan has witnessed a rapid industrial development in the last twenty years. This has led to the release of waste materials or pollutants into the marine environment, particularly near Aqaba Port. The levels of zinc, cadmium and lead were determined in four brown algae, three red algae and four green algal species collected from Aqaba. Three different levels of lead and zinc were exhibited among brown algae. Intermediate levels were exhibited among red algae and the lowest level was seen among the green algae. Very low concentrations of cadmium were found in all examined algal species. The results indicated that the brown algal species Cystosira myrica, Sargassum asperifolium, Sargassum neglectum and Sargassum subrepandum always contain the highest concentrations of lead and zinc, but these algae are less contaminated than brown algae from European seas near industrialized areas.
Index terms: heavy metal algae Red Sea /Algae, brown/Algae, green/ Algae, red (heavy metals of, from Red Sea) /Water pollution (heavy metals of marine algae from Red Sea in relation to) /Trace elements, metals, heavy,biological studies (of marine algae, from Red Sea)

211. Miller, J.D.
An assessment of the conservation status of marine turtles in Saudi Arabia.
1989.
(MEPA coastal and marine management series report ; no. 9A)

212. **Ministries discuss ways to help contain oil spill.**
Japan Economic Newswire, Jan 28, 1991.

213. **Ministries struggle to find response to gulf oil slick. (Japan, Persian Gulf).**
Japan Economic Newswire, Jan 29, 1991.

214. MITCHELL, RALPH (Harvard Univ., Div. of Engineering and Applied Physics, Cambridge, Mass.)
THE EFFECTS OF POLLUTANTS ON MARINE MICROBIAL PROCESSES: A FIELD STUDY.
SEP 1974. 44 p.
Report #: NTIS REPORT AD-787 602.

PREVIOUS STUDIES HAVE SHOWN THAT LOW CONCENTRATIONS OF CHEMICAL POLLUTANTS ADVERSELY AFFECT MICROBIAL PROCESSES IN SEAWATER. A FIELD STUDY OF THIS PHENOMENON WAS UNDERTAKEN, WITH RED SEA CORALS AS A MODEL. LOW CONCENTRATIONS OF CRUDE OIL, COPPER, AND AVAILABLE ORGANIC MATTER, WHICH WERE INSUFFICIENT TO KILL THE CORALS DIRECTLY, UPSET THE MICROBIOLOGICAL BALANCE ON THE CORAL'S SURFACE. THE POLLUTANTS STIMULATED EXCESSIVE MUCUS PRODUCTION BY THE CORAL. BACTERIA WERE ATTRACTED TO THE MUCUS AND GREW ON IT. THREE FACTORS ASSOCIATED WITH BACTERIA GROWTH WERE RESPONSIBLE FOR THE DEATH OF THE CORAL COLONIES: OXYGEN DEPLETION, CHEMICAL TOXINS, AND BACTERIAL PREDATORS, PARTICULARLY BEGGIOTOA.
Index terms: MARINE POLLUTION DAMAGE /MICROORGANISMS /CORAL REEFS / HYDROCARBONS-WATER /COPPER /BACTERIA /PREDATORS /DISSOLVED OXYGEN / PATHOLOGY, ANIMAL /RED SEA

215. Moazzam, M., and S.H. N Rizvi (Inst. Marine Biol., Karachi)
Overview of Oil Pollution Along the Coast of Pakistan.
Nat. & Reg. Sem. for Protection of Marine Environ. & Related Eco-Sys. in ESCAP Region IN "PROTECTION OF MARINE ENVIRON.
Karachi, Pakistan : PAKISTAN COUNCIL OF SCI. & INDUST. RES. LAB., p. 33-39.

At the present oil pollution along the Pakistani coast appears to be caused by heavy maritime traffic along its coast, bilge cleanings from ships and from local mechanised boats, effluents from refineries and industrial and untreated municipal wastes. No serious study is available in this area excepting those of Haq and Ahmed who have dealt with marine pollution in the coastal waters of Pakistan including a brief account of pollution from oil. A few reports are also available on oil pollution along the Indian coast and Persian Gulf. Considering the potential impact of oil pollution on marine life and its increasing level along the coast of Pakistan, it is highly desirable to initiate a study for a better understanding of its possible effects on local marine organisms including our fisheries resources.
Index terms: Oil pollution/Marine environments/Coastal waters/ Refineries/Environmental impact/Aquatic organisms/Industrial wastes /Persian Gulf/Indian Coast

216. Moore, Nicholas
Greens may have windfall from Gulf crisis. (ecologists, Persian Gulf).
Reuters Newswire, August 10, 1990.

217. Morris, R.J. (Inst. Oceanogr. Sci.; Wormley/Godalming/Surrey;)
Lipid composition of surface films and zooplankton from the Eastern Mediterranean.
Mar. Pollut. Bull., vol. 5, no. 7. p. 105-9, 1974.

The natural surface films in the Eastern Mediterranean appear to be badly polluted with petroleum hydrocarbons, and sub-surface oil/water emulsions are also important contributors to the interface chemistry in certain areas. High levels of non-natural hydrocarbons are present in the lipids of some near-surface zooplankton from this region, suggestion that these animals store and concentrate the pollutant hydrocarbons.
Index terms: lipid surface water zooplankton Mediterranean /Water pollution (by hydrocarbons, in Mediterranean) /Lipids (in water and zooplankton, of Mediterranean) /Waters, ocean (lipids in, of Mediterranean) /Hydrocarbons, biological studies water pollution by, in Mediterranean) /Plankton (zoo-, lipids in, of Mediterranean)

218. Morris, R.J., and F. Culkin (Inst. Oceanogr. Sci.; Godalming; England)
Lipid chemistry of eastern Mediterranean surface layers.
Nature (London), vol. 250, no. 5468, p. 640-2, 1974.
Index terms: water sea lipid Mediterranean/seawater lipid Mediterranean/zooplankton lipid petroleum pollution/crustacean lipid

petroleum pollution/fish lipid petroleum pollution/lipid marine life petroleum /Water pollution(by petroleum, of Mediterranean Sea) Lipids (of marine life, petroleum hydrocarbons in, of Mediterranean Sea) /Crustacean/Fish (petroleum hydrocarbons in, of Mediterranean Sea) /Petroleum (water pollution by, of Mediterranean Sea) /Plankton (zoo-, petroleum hydrocarbons in, of Mediterranean Sea)

219. Moursy, A.S.; M. El-Debb; O.T. Magoon; H. Converse; D. Miner; L.T. Tobin; D. Clark, and G. Domurat (National Research Centre, Dokki, Cairo (EG)
Oil pollution in Suez Gulf of the Red Sea.
Coastal zone '87 - 5. symposium on coastal and ocean management, 1987.

The Red Sea, being in a hot and semi-arid climate, has a high water temperature and salinity. The Red Sea is an important recreation area and valuable source of fishery and has a potential economic value at the national levels. The species of fish and natural marine resources are too numerous to mention. However, oil spills have a deteriorating effect on these food sources as well as fouling the fishing gear of the Red Sea fishermen. The population along the Red Sea coast is small, but this sea is now one of the most important areas in the world, for it is the route for ships using the Suez Canal. Many vessels transit the Canal daily, and each of these vessels pumps its bilges and disposes of its garbage in the most convenient way directly into the sea. Even if bilge pumping and garbage disposal by each vessel were minimal the cumulative effect is enormous. Results obtained by this study show that the oil pollutants in the sea water is low. Oil pollution of the beach is possibly due to the improper handling of crudes resulting from exploration and production activities, loading and unloading operations. Offshore activities are the major source of pollution of the beach area and weathering of spilled oil leads to the formation of tar balls.
Index terms: GULF OF SUEZ -- ENVIRONMENTAL TRANSPORT/GULF OF SUEZ --OIL SPILLS/PETROLEUM RESIDUES -- BIOLOGICAL EFFECTS/PETROLEUM RESIDUES--ECOLOGICAL CONCENTRATION/PETROLEUM RESIDUES--ENVIRONMENTAL EFFECTS/PETROLEUM RESIDUES -- HEALTH HAZARDS/SHORES -- POLLUTION SOURCES /AQUATIC ORGANISMS/BIOLOGICAL ACCUMULATION/SHIPS/ SOLID WASTES/WATER CHEMISTRY/WATER POLLUTION /CHEMISTRY/ENERGY SOURCES/FOSSIL FUELS/FUELS/HAZARDS /MASS TRANSFER/PETROLEUM/PETROLEUM FRACTIONS/POLLUTION/RED SEA/ SEAS/SURFACE WATERS/WASTES

220. MUFSON, STEVE
IRAN-IRAQ WAR PREVENTS OIL CLEANUP,.

WALL STREET J, p. 21, APR 4, 1983.

A HUGE OIL SPILL FROM IRAN'S OFFSHORE NORWUZ OIL FIELD IS SPREADING INTO THE PERSIAN GULF AND THREATENS FISHERIES, SHIPPING, AND VITAL WATER DESALINATION PLANTS IN THE REGION. IRAN ASKED U.S. FIRMS TO INITIATE EMERGENCY REPAIRS, BUT IRAQ, AT WAR WITH IRAN,HAS THREATENED MILITARY ACTION IF SUCH A CLEANUP IS ATTEMPTED. OTHER PERSIAN GULF COUNTRIES WHO HAVE BEEN IRAQ'S CLOSEST ALLIES HAVE PRESSURED IRAQ TO ALLOW CLEANUP OF THE OIL SPILL, WHICH IS 2-5 MI WIDE AND 250 MI LONG. (1 MAP)
Index terms: OIL SPILLS-PLATFORM /PERSIAN GULF /IRAN /IRAQ /WARFARE /WATER SUPPLY /POLITICS, ENV-INTL

221. Murphy, Kim
Coast Guard official sees little hope of full oil spill cleanup. (Don Jensen's report on Persian Gulf oil spill) (The Gulf War).
Los Angeles Times, Jan 31, 1991, v110 col 1, pA10.

222. Murphy, Kim
U.S. bombing appears to halt Gulf oil spill. (raid on oil pumping facilities in Kuwait may arrests oil dumped into Persian Gulf).
Los Angeles Times, Jan 29, 1991, v110 col 4, pA1.

223. Mustaffi, Z., and H. Amann
Ocean mining and protection of the marine environment in the Red Sea.
Proceedings: Tenth Annual Offshore Technology Conference, 1978.
p. 1199-1214.

By all standards the Red Sea constitutes a unique marine environment. A highly diversified, rich and varying fauna and flora at the reef covered coasts and delicately organized pelagic life and benthos in deep graben waters combine with the yet largely unknown hydrography and the particular geology of a nascent ocean into an ecological system of great importance to the scientific community. This ecosystem is, at the same time, exposed to extreme natural influences: intensive sun irradiation, constant and hot winds, and subsequent evaporation with negligible inflow of terrestrial water and a reduced exchange of fresh ocean water over the southern sill of Bab el Mandab. Salinity and temperature of the water are thus higher and oxygen and nutrient contents are lower than in other seas of the world. This results in carefully balanced metabolisms of the ecosystem. New technologies such as ocean mining of the Red Sea metalliferous muds must be concerned with the environment and its safeguarding. With this understanding the

Saudi Sudanese Red Sea Joint Commission has entrusted Preussag in 1976 with the technical development of occurrences of ore bearing muds (Zn, Cu, Ag) in the deep sea graben. A comprehensive program is being carried out: monitoring the deep sea and coastal environment and designing for their protection, test production and controlled redeposition of tailings and sediments in graben areas as well as beneficiation and metallurgy of the complex marine ores. A description of the task and preliminary results of recent research and development work until early 1978 are given together with an outlook on forthcoming steps.
Index terms: water pollution effects/resources development/ environmental effects/mining/Outer Continental Shelf/ecosystems/ pollutant abatement/deep-sea mining/Red Sea

224. **NAPIS 75-0011 Oceanic Tritium Profiles, 1965-1972.**
User Services Branch National Oceanographic Data Center National Environmental Satellite, Data and Information Service NOAA, Washington, DC, 1974.
Geographic Area - North Atlantic, South Atlantic, Meditterean Sea, Black Sea.

Contains essentially all tritium results obtained on oceanic samples collected between 1965 and early 1972, processed by the University of Miami laboratory, with the exception of those from the GEOSECS test cruises. The work was supported by the National Science Foundation. The samples were collected by various platforms and operators. Depth, temperature, and salinity have been obtained through the chief scientist of each expedition, or his institution.

225. Nasr, D.H. (National Council for Research, Port Sudan)
Observations on the mortality of the pearl oyster, Pinctada margaritifera, in Dongonab Bay, Red Sea.
Aquaculture (Netherlands), vol. 28, no. 3/4, Jul 1982.

The cultivaton of the pearl oyster, Pinctada margaritifera, has been successful in Dongonab Bay since 1904. In 1969 a massive mortality swept the bay, followed by another in 1973. The cause of the 1969 mortality remains unknown but the latter mortality has been investigated. Studies of the environmental conditions, parasites, trace metal poisoning and microbial diseases suggest that the cause of the 1973 mortality was probably an unidentified spherical parasite.|;
Index terms: ARSENIC -- ECOLOGICAL CONCENTRATION/CADMIUM -- ECOLOGICAL CONCENTRATION/COPPER -- ECOLOGICAL CONCENTRATION/LEAD -- ECOLOGICAL CONCENTRATION/LEAD -- ECOLOGICAL CONCENTRATION/OYSTERS -- MORTALITY / RED SEA -- OYSTERS/ZINC -- ECOLOGICAL CONCENTRATION /AQUACULTURE/

BIOLOGICAL ACCUMULATION/CHEMICAL ANALYSIS/DISEASES/ WATER POLLUTION / ANIMALS/AQUATIC ORGANISMS/ELEMENTS/INVERTEBRATES/ METALS/MOLLUSCS/ POLLUTION/SEAS/SEMIMETALS/SURFACE WATERS/ TRANSITION ELEMENTS

226. Neff, J.M.; J.P. Marum, and J.S. Warner (Battelle New England Marine Res. Laboratory, Duxbury, MA)
Composition and fate of clean ballast water discharged from crude oil tankers.
1983 Oil Spill Conference: American Petroleum Institute conference on oil spill, p. 435-442, Feb 1983.

According to Intergovernmental Maritime Consultative Organization protocols (MARPOL 73/78), clean ballast water (producing no surface sheen and/or containing less than 15 parts per million total oil) from crude oil cargo tanks of tankers can be discharged into coastal waters. As part of an assessment of the potential impact of clean ballast water discharges on Red Sea coral reefs, we have determined the hydrocarbon composition of clean ballast water from crude oil cargo tanks and have determined its rate of dilution following discharge to coastal waters at Yanbu, Kingdom of Saudi Arabia. In 52 clean ballast water samples from 10 crude oil tankers, total petroleum hydrocarbon concentrations, measured by gas chromatography, ranged from 0.09 to 11 milligrams/liter (ppm). In most cases, the dominant hydrocarbons in the samples were C11 through C20 n-paraffins. Up to 58 micrograms/liter (ppb) total naphthalenes and 744 ..mu..g/l benzene, toluene, and ethylbenzene combined were detected in some samples. Clean ballast water was diluted rapidly upon discharge to the ocean. Dilutions of 100-fold or greater were observed within 10 to 20 meters of the discharge and dilutions of 500 to 1,000-fold were measured 1,500 to 2,000 meters downcurrent and within two to four hours of the discharge. Based on these results, it is predicted that discharge of clean ballast water to the coastal waters of the Red Sea in compliance with MARPOL 73/78 rules will have little or no adverse impact on coral reefs of the area.
Index terms: RED SEA -- WATER POLLUTION CONTROL/TANKER SHIPS -- WATER/WASTE WATER -- CHEMICAL COMPOSITION /CHEMICAL ANALYSIS/COASTAL WATERS/ENVIRONMENTAL IMPACTS/HYDROCARBONS/ MONITORING/REEFS/SAMPLING/ SAUDI ARABIA /ASIA/CONTROL/GEOLOGIC STRUCTURES/HYDROGEN COMPOUNDS/ LIQUID WASTES/ORGANIC COMPOUNDS/OXYGEN COMPOUNDS/POLLUTION CONTROL/ SEAS/SHIPS/SURFACE WATERS/WASTES/WATER

227. Nemirovskaya, I.A. and Bordovskii, O.K.

Petroleum pollution of surface waters.(editor)
Biogidrokhim. Sev.-Zapadn. Chasti Indiiskogo Okeana,.Izd. Nauka, Moscow, USSR, 1981. p. 97-102.
Index terms: petroleum pollution surface seawater/arom hydrocarbon pollution surface seawater /Petroleum (arom. hydrocarbons of, seawater pollution by, of Indian and Atlantic oceans and Mediterranean and North Seas) /Water pollution (by petroleum, of Indian Ocean and Mediterranean Sea and Atantic Ocean and North Sea) /Aromatic hydrocarbons,biological studies (seawater pollution by, of Persian Gulf and Mediterranean Sea and North Sea)

228. Nemirovskaia, I.A.
Study of sea pollution by oil and oil products conducted during the 22-month voyage of Scientific Research Ship Academician Kurchatov.
Okeanologiya (Moscow) (USSR), vol. 19, Jan 1979.

The paper presents observational data on nine oil slicks found over a 22-month voyage in the Black Sea, Persian Gulf, Mediterranean Sea, and North Sea. The distribution of hydrocarbons in the study areas, which also included the North Atlantic, the Red Sea, the Indian Ocean, and the Gulfs of Aden and Oman, was determined by recording the number of probes having hydrocarbon concentrations in five different intervals.|;
Index terms: HYDROCARBONS -- ECOLOGICAL CONCENTRATION/HYDROCARBONS -- SPATIAL DISTRIBUTION/SEAS -- OIL SPILLS/SEAS -- WATER POLLUTION / ATLANTIC OCEAN/BLACK SEA/INDIAN OCEAN/MEDITERRANEAN SEA/MONITORING/ NORTH SEA/PERSIA GULF/TAR /ARABIAN SEA/ATLANTIC OCEAN/DISTRIBUTION/ INDIAN OCEAN/ORGANIC COMPOUNDS/OTHER ORGANIC COMPOUNDS/POLLUTION/SEAS/ SURFACE WATERS

229. Neuman, L.D. (U.N. Dep. Int. Econ. Soc. Affairs)
Protection and development of the marine environment and coastal areas of the Kuwait conference region: the program of the United Nations system.
Am. Pet. Inst., Publ. (United States). Oil spill conference: prevention, behavior, control, cleanup, vol. 43, no. 8, 1979.

Because of the threat of massive oil spills in the Persian Gulf, the countries of the region developed the Kuwait Action Plan (KAP) under the coordination of the United Nations Environment Program. The first component of the KAP is an environmental assessment, including socioeconomic development activities related to environmental quality. This assessment demonstrated the coincidence of highly vulnerable

areas with the areas to which oil is most likely to be transported. The second component aims to develop guidelines for the management of those activities which have an impact on environmental quality or on the protection and use of renewable marine resources on a sustainable basis. The legal component, which provides the legal basis for cooperative efforts to protect and develop the region, consists of protocols which provide for the establishment of a Marine Emergency Mutual Aid Centre. The Persian Gulf area is discussed in terms of the physical setting, development activities, oil and natural gas activities, and the oil spill risk.
Index terms: OIL SPILLS -- LEGAL ASPECTS/WATER POLLUTION ABATEMENT -- EMERGENCY PLANS /ENVIRONMENTAL QUALITY/INTERNATIONAL COOPERATION/ KUWAIT/RESOURCE CONSERVATION/RISK ASSESSMENT /ASIA/COOPERATION/ MIDDLE EAST/POLLUTION ABATEMENT

230. Newell, R.E.; S.T. Shipley; V.S. Connors, and H.G., Jr. Reichle-Seiler, W. (Dep. Earth, Atmos. and Planet. Sci., Rm. 54-1522, Massachusetts Inst. Technol., Cambridge, MA)
Regional studies of potential carbon monoxide sources based on space shuttle and aircraft measurements.
Influence of Marine and Terrestrial Biosphere on the Chemical Composition of the Atmosphere, 1988. p. 61-81.

Carbon monoxide measurements made from the space shuttle show maxima over South America, central Africa, the eastern Mediterranean, and China. The maxima appear to be associated with either concomitant or prior convection in the air masses which carries boundary layer air into the upper troposphere. Previous aircraft measurements of carbon monoxide and ozone over South America are shown to be consistent with this view. In the tropics the three regions of long-term mean rising motion, which form part of the Walker circulation, are associated with elevated carbon monoxide.
Index terms: remote sensing/carbon monoxide/pollutant dispersion/ monitoring measurements/atmosphere

231. NISBETT, ALEC.
CROWN-OF-THORNS IN THE RED SEA.
NEW SCIENTIST, APR 12, 1973, vol. 58, no. 841, p. 74-78.
Index terms: FISH/AQUATIC COMMUNITIES/CORAL REEFS/PREDATORS/MARINE POLLUTION

232. Nissenbuam, Arie; Ronald Eisler, and Yuval Cohen
Effects of Iranian crude oil on the Red Sea octocoral Heteroxemia fuscescens.

Environmental Pollution, vol. 11, no. 3, p. 173-?, March 1977.
Index terms: crude oil, Iranian, effects/water pollution (marine)/
Heteroxemia fuscescens/octocoral, Red Sea

233. **OECD accuses Iraq of 'crime' against environment. (Organization for Economic Cooperation and Development).**
Japan Economic Newswire, Jan 31, 1991.

234. **OECD meeting to seek international cooperation for gulf spill. (Organization for Economic Cooperation and Development, Persian Gulf)**
Japan Economic Newswire, Jan 29, 1991.

235. **Oil fire at Kuwait's Wafra field said set by Iraqis; source of blaze uncertain. (Cover Story).**
Platt's Oilgram News, Jan 23, 1991, v69 n16, p1(2).
ARTICLE TYPE: Cover Story

236. **Oil leaking from Iraqi tankers hit by U.S. in Gulf. (Persian Gulf War, 1991-).**
Japan Economic Newswire, Jan 24, 1991.

237. **Oil slick kills Gulf shrimping. (International Pages) (War in the Gulf).**
New York Times, Feb 6, 1991, v140 col 6, pA7(N) pA9(L).

238. **Oil slick slowed by Saudi beach. (Persian Gulf oil spill) (International Pages) (War in the Gulf).**
New York Times, Feb 11, 1991, v140 col 6, pA6(N) pA12(L).

239. **Oil spill in Gulf hinders fishing, desalination.**
Aviation Week & Space Technology, May 23, 1983, v118, p44(2).

240. **The oily mess in Persian Gulf.**
U.S. News & World Report, April 18, 1983, v94, p9(1).

241. Oostdam, B.L. (Millersville State College, PA)
Oil pollution in the Persian Gulf and approaches, 1978.
Marine Pollution Bulletin (United Kingdom), vol. 11, no. 5, p. 138-145, May 1980.

An analysis of vessel reports of oil slicks in the Persian Gulf and approaches during 1978, as compiled by the Japanese Oceanographic Data Center showed an increase in the number and percentages of positive reports towards the Strait of Hormuz. Most slicks appeared to

represent separate events. Of the ten major slicks, which were all "thin", averaging 13..mu..m in thickness, seven were reported by 2 out of 84 vessels. Collectively, they contained 73% of all oil in 139 reported slicks; the largest slick contained > 54,000 cu m, and all slicks combined totaled 160,000 cu m. Pronounced seasonal variations in slick characteristics included an increase in the number, size, and areal coverage during winter, but an increase in thickness in summer. Slick dispersal patterns agreed with prevailing wind and surface current calculations. Comparison with published data for other oceans indicated that these spill rates account for 15 to 20% of the total amount of oil spilled worldwide.
Index terms: OIL SPILLS -- COMPARATIVE EVALUATIONS/PERSIAN GULF -- OIL SPILLS/PERSIAN GULF -- WATER POLLUTION /GLOBAL ASPECTS/MARITIME TRANSPORT/PETROLEUM/SEASONAL VARIATIONS/ SIZE/SURVEYS/WATER CURRENTS/ WIND /ARABIAN SEA/CURRENTS/ENERGY SOURCES/FOSSIL FUELS/ FUELS/INDIAN OCEAN/POLLUTION/SEAS/SURFACE WATERS/TRANSPORT/ VARIATIONS

242. Oostdam, B.L. (Millersville Univ., PA)
Tar pollution of beaches in the Indian Ocean, the south China Sea and the South Pacific Ocean.
Mar. Pollut. Bull. (United Kingdom), vol. 15, no. 7, Jul 1984.

During 1978, a comparative survey was made of the degree of pollution of 265 beaches in the Indian Ocean, the South China Sea, the South Pacific and along the Southern California Bight, the Mid-Atlantic Bight and the Dutch North Sea. Part of the results were published recently and elicited a number of requests for the full data set, which is, therefore, summarized in this note. Generalized observations on tar pollution are: (1) strandings from individual spills could rarely be correlated over distances longer than a few km; (2) tar is concentrated in distinct bands parallel to the water line; (3) there is a pronounced trend of vertical zonation of tar from smaller, well-rounded and soft particles near the water line to larger, flattened and hardened lumps landward; (4) buried tar is relatively uncommon, suggesting a residence time of around 30-90 days in the tropics; (5) tar concentrations display high variability indicating the need for large numbers of samples; (6) prevailing wind regimes are the main cause for seasonal variations in tar strandings. The highest beach tar concentrations were found in areas of oil production or near tanker routes, especially in enclosed seas; Persian Gulf, Red Sea and South China Sea.
Index terms: OIL SPILLS -- ENVIRONMENTAL EFFECTS/TAR -- ENVIRONMENTAL TRANSPORT/TAR --LAND POLLUTION /CHINA

SEA/COASTAL REGIONS/EXPERIMENTAL DATA/GLOBAL ASPECTS/INDIAN OCEAN/PACIFIC OCEAN/POLLUTION SOURCES/ TABLES/TANKER SHIPS/WATER POLLUTION /DATA/INFORMATION/MASS TRANSFER/ NUMERICAL DATA/ ORGANIC COMPOUNDS/OTHER ORGANIC COMPOUNDS/PACIFIC OCEAN/POLLUTION/ SEAS/SHIPS/SURFACE WATERS

243. Ormond, R.F. G., and D.I. Walker
Coral death from sewage and phosphate pollution at Aqaba, Red Sea.
Marine Pollution Bulletin, vol. 13, no. 1, p. 21-?, Jan. 1982.
Index terms: coral mortality/sewage pollution/eutrophication/phosphate pollution/Stylophora pistillata

244. OTTERMAN, JOSEPH; GEORGE OHRING, and AVIHU GINZBUR
RESULTS OF THE ISRAELI MULTIDISCIPLINARY DATA ANALYSIS OF ERTS-1
IMAGERY.
REMOTE SENSING ENV, 1974, vol. 3, no. 2, p. 133-149.

THE ANALYSIS OF ERTS IMAGERY OF ISRAEL AND ITS VICINITY IS REVIEWED IN THE FIELDS OF ARID REGIONS VEGETATION STUDIES, OCEANOGRAPHY, ATMOSPHERIC AND CLOUD STUDIES, POLLUTION OBSERVATIONS, GEOLOGY, AND GEOMORPHOLOGY. THE USEFULNESS OF THE FOUR SPECTRAL BANDS OF THE MULTI-SPECTRAL SCANNER IS ASSESSED. IMAGERY DETECTED OIL SLICKS IN THE GULF OF SUEZ. THE MOST INTERESTING OBSERVATION FROM THE OCEANOGRAPHIC VIEW POINT IS THE DISCOVERY OF A GIANT EDDY, SOME 30 KM IN DIAMETER, IN THE MIDDLE OF THE GULF OF SUEZ, AT THE NORTHERN END OF THE RED SEA. (1 MAP, 11 PHOTOS, 23 REFERENCES)
Index terms: ISRAEL /EARTH RESOURCES TECH SATELLT /OCEANOGRAPHY /
GEOLOGY / OIL SPILL DETECTION /PLANT COVER /METEOROLOGY

245. **Output halted at Amoco platform in Gulf of Suez. (Gulf of Suez Petroleum Co.)**
Reuters Newswire, Dec 11, 1989.

246. Parrish, Michael
New oil cleanup technologies face crucial test in Gulf. (Persian Gulf).
Los Angeles Times, Jan 30, 1991, v110 col 5, pD1.

247. Parrish, Michael
Oil spill threatens region's water supply with disaster. (Persian Gulf region) (The Gulf War).

Los Angeles Times, Jan 26, 1991, v110 col 3, pA6.

248. PARVANEH, VIDA (UNIV OF TEHRAN, IRAN,)
AN INVESTIGATION ON THE MERCURY CONTAMINATION OF PERSIAN GULF FISH.
BULL ENV CONTAM & TOX, OCT 1979, vol. 23, no. 3, p. 357-360.

MERCURY CONCENTRATIONS IN FOUR IMPORTANT FISH SPECIES FROM THE PERSIAN GULF WERE ESTIMATED. MERCURY COULD ORIGINATE FROM EITHER NATURAL GEOLOGICAL FORMATIONS OR INDUSTRIAL DISCHARGES IN THE COASTAL AREA. ACID DIGESTION OF THE EDIBLE FISH PARTS, AND ANALYSIS BY FLAMELESS ATOMIC ABSORPTION SPECTROPHOTOMETRY INDICATED THAT MERCURY LEVELS RANGED FROM 0.04-0.56 MG/KG. MEAN VALUES AND THE RANGE FOR EACH SPECIES ARE TABULATED. THESE VALUES WERE MUCH LOWER THAN THE MERCURY CONTENT OF CANNED TUNA FISH. THE MERCURY LEVELS FOUND DO NOT POSE A PUBLIC HEALTH PROBLEM, BUT CONTROLS ARE SUGGESTED TO PREVENT SEVERE CONTAMINATION IN THE FUTURE. (12 REFERENCES, 1 TABLE)
Index terms: MERCURY /BIOACCUMULATION-FISH /PERSIAN GULF / METHYLMERCURY / WATER POLLUTION, NATURAL /BIOASSAY /ATOMIC ABSORPTION / CONTAMINATION INCIDENTS /MARINE ORGANISMS

249. Parveneh, V. (Tehran Univ., Dept. of Food Hygiene, Tehran, Iran)
A survey on the mercury content of the Persian Gulf shrimp.
Bulletin of Environmental Contamination and Toxicology., vol. 18, no. 6, p. 778-792, 1977.

The mercury content of the edible part of the commercially important Persian Gulf Shrimp was analyzed. The level of mercury in the 100 samples examined ranged from 0.08 to 0.88 mg/kg with a mean value of 0.24 mg/kg and a standard deviation of 0.18. These values did not exceed proposed mercury content limit for human consumption.
Index terms: mercury/shrimp/toxicity/public health/heavy metals/ methylmercury/Persian Gulf/commercial shellfish/spectrometry/water pollution effects/crustacean/chemical analysis/bioaccumulation/tissue analysis

250. Pearce, F.
Gulf War could mean largest ever oil spill.
New Science, vol. 129, no. 1752, p. 18. Jan. 19, 1991.

251. Perrenou, C. ; Rose, P. and Poole, C.

Asian waterfowl census 1990.
IWRB, 1990.

252. **Persian Gulf nations have signed an antipollution pact.**
Chem. Eng. News (United States), vol. 56, no. 20, 15 May 1978.

Persian Gulf nations have signed an antipollution pact at an Apr. 1978 conference convened by the United Nations Environment Program. At the conference, Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the United kArab Emirates agreed to antipollution treaties involving collaboration in preventing damage to their marine ecosystems. A far-ranging action plan was adopted, and a $6.32 million regional trust fund was created to help pay for its cost. Features of the Persian Gulf that make it susceptible to pollution (e.g., a low purging capacity, heavy industrialization, and heavy concentration of oil tanker traffic in the Persian Gulf) and various aspects of the treaty are discussed.
Index terms: PERSIAN GULF -- WATER POLLUTION CONTROL/WATER POLLUTION CONTROL -- INTERNATIONAL AGREEMENTS /COST/PETROLEUM INDUSTRY/POLLUTION REGULATIONS/UNITED NATIONS /AGREEMENTS/ARABIAN SEA/CONTROL/INDIAN OCEAN/ INDUSTRY/INTERNATIONAL ORGANIZATIONS/POLLUTION CONTROL/ REGULATIONS/ SEAS/SURFACE WATERS

253. Philips, Charles
The battle for oil. (energy vs. ecology) (includes related article).
American Legion Magazine, June, 1989, v126, p20(2).

254. Pickett, R.L.; R.M. Partridge; R.A. Arnone, and J.A. Galt (Nav. Ocean Res. Dev. Act., Bay St. Louis, MS, USA ENGLISH)
The Persian Gulf, oil and natural circulation.
SEA TECHNOL, 1984, p. 23-25.

The Kingdom of Saudi Arabia requested the help of the U.S. government in analyzing the natural circulation of the Persian Gulf. The concern for Saudi Arabia was to find out whether the increasing spillage of oil into Gulf waters as a result of the Iran-Iraq war would be likely to end up on its shores and foul the desalination plants in the area. Oil particles, following the model circulation pattern at a mean speed of 20 cm/sec would require several months to travel the total length of the Persian Gulf. During such a trip, tidal and inertial currents would spread the oil with oscillations of about 10 to 20 kilometers. This wind and current combination should result in oil moving south and east from sources in the northern end of the Persian

Gulf, and should preserve the desalination plants along the western shores from any adverse impact from the spills.
Index terms: oil spills/marine pollution/remote sensing/satellites

255. Pickett, R.L.; R.M. Partridge, and R.A. Arnone (NORDA, NSTL, MS)
The Persian Gulf via satellites.
OCEANOGR. MONTH. SUMM, 1984, p. 3.

On March 2, 1983, Iraq aircraft destroyed an Iranian oil rig in the north end of the Persian Gulf. A few weeks later more rigs in this area were destroyed by Iraq. The amount of oil entering the Gulf was estimated at 2,000 barrels/day, but may have reached 18,000 barrels/day as damaged rigs melted down and the oil-consuming fires went out. To help understand the spills' movement, 7 satellite-tracked drifting buoys were launched in the Persian Gulf. The buoys transmitted data to NOAA-7 and 8 satellites. Drifter positions were determined by Doppler shift at the ARGOS processing center in Toulouse, France. The buoys were mounted on slings, fitted with drogues, and deployed from helicopters off the Saudi Arabian coast in late May 1982. They washed ashore from 5 to 29 days later. Satellite pictures were also reviewed for positions of the spilled oil. The NOAA-7 satellite visible and infrared bands on March 29, 1983 showed a dark, warm streak heading southeast, probably the oil slick from the damaged rigs. The pattern of the drifter tracks and the oil slick suggest a two gyre circulation on the Persian Gulf.
Index terms: oil spills/marine pollution/satellites/remote sensing/pollutant dispersion

256. Price, A.R. G.; T.J. Wrathall, and S.M. Bernard (Dep. Biol.; Univ. York; York; UK; YO1 5DD)
Occurrence of tar and other pollution on the Saudi Arabian shores of the (Persian) Gulf.
Mar. Pollut. Bull., vol. 18, no. 12, p. 650-1, 1987.
Index terms: seawater pollution beach tar oil /Waters, ocean (oil spills on, of Persian Gulf, Saudi Arabian beach contamination in relation to) /Petroleum, oil spills (on seawater, of Persian Gulf, Saudi Arabian beach contamination in relation to)

257. **Proceedings of the Symposium/Workshop on Oceanographic Modelling of the Kuwait Action Plan (KAP) region.**
[S.l.] : UNESCO/ROMPE/UPM/UNEP, 1985.
(UNEP regional seas reports and studies ; no. 70)

258. **Protecting the Persian Gulf. (fighting pollution).**
America, April 18, 1981, v144, p307(2).

259. Raloff, Janet; Monastersky, Richard
Gulf oil threatens ecology, maybe climate. (Persian Gulf oil spill)
Science News, Feb 2, 1991, v139 n5, p71(2).

260. Ramsar Convention Bureau, Slimbridge, U.K.
Directory of wetlands of international importance.
Gland, Switzerland : IUCN ; The Bureau, 1990.

261. Ravid, Rosa; O.H. Oren; Josepha Ben-Yosef, and Hava Hornung
(Environ. Eng. Lab.; Technion-Israel Inst. Technol.; Haifa; Israel)
Oil pollution in the eastern Mediterranean.
Mar. Pollut. Bull., vol. 16, no. 2, p. 81-4, 1985.
Index terms: oil pollution Mediterranean Sea/coast water oil pollution Israel/petroleum water pollution Mediterranean Sea /Water pollution (by petroleum oils, of Israeli shoreline and eastern Mediterranean Sea) /Petroleum,oil spills (water pollution by, in eastern Mediterranean Sea and Israeli shoreline) /Petroleum products (water pollution by, of Israeli shoreline and eastern Mediterranean Sea) / Hydrocarbons, biological studies (water pollution by petroleum-based, of eastern Mediterranean Sea)

262. **Red Sea decline.**
Marine Pollution Bulletin, vol. 11, no. 5, p. 115-?, May 1980.
Index terms: marine pollution/Red Sea

263. **Regional protection.**
International and United States documents on oceans law and policy., Volume 2 1986.

The Regional Protection section includes 11 documents dealing with the protection of specific regions and seas from oil spill and other water pollution damage. Each agreement stresses the importance of international agreement on the desirability of protecting the environment and international cooperation in effecting the treaties and maintaining them. The North, Baltic, Caribbean, Mediterranean, and Persian Gulf areas are the focus of the documents. Signatories of some are multinational, while others are bilateral agreements. The title page of each document includes full citation, although some documents may be edited to save space.
Index terms: OIL SPILLS -- INTERNATIONAL COOPERATION/SEAS -- WATER POLLUTION CONTROL/WATER POLLUTION CONTROL -- INTERNATIONAL

LAWS / BILATERAL AGREEMENTS/ENVIRONMENTAL POLICY/LEGAL ASPECTS/REGIONAL COOPERATION/TREATIES /AGREEMENTS/CONTROL/COOPERATION/GOVERNMENT POLICIES/ INTERNATIONAL AGREEMENTS/LAWS/POLLUTION CONTROL/SURFACE WATERS

264. **R/V Trident Cruise TR 028 Data.**
Journal of Geophysical Research, Vols. 80, 79 (Nos. 21 and 15):pp. 3013-3031 and 2243-2250, July 20, 1975 and May 20, 1974.
Geographic Area - North Atlantic, Azores to Mediterranean and to Casablanca.

Silica, salinity, and dissolved oxygen data was collected at 28 hydrocast stations and interstitial silica data from 11 gravity core stations on a cruise from the Azores through the Mediterranean Sea and Back to Casablanca.

265. **R/V Vema, Cruise 14 - MGG01035014 -Core Description (Geology).**
Marine Geology and Geophysics Group NationalGeophysical and Solar Terrestrial Data Center NOAA/EDS, Boulder, Colo., Nov. 1957 - Sept. 1958.
Geographic Area - North Atlantic Ocean, South Atlantic Ocean, Meditterranean Sea, Indian Ocean.

Detailed magascopic sediment descriptions of split piston cores collected aboard the R/V Vema, Cruise 14 by Columbia University's Lamont-Doherty Geological Observatory. Parameters reported also include latitude, longitude, corrected depth, P.D.R. depth, data taken, date opened flow-in, and core length, as well as microscopically estimated palentology, mineralogy, and sediment size.

266. RINKEVICH, B., and Y. LOYA
HARMFUL EFFECTS OF CRUDE OIL ON A RED SEA CORAL POPULATION.
ISR J ZOOL, 1976, p. 205.
Index terms: STYLOPHORA-PISTILLATA/POLLUTION

267. Rinkevich, B., and Y. Loya (George S. Wise Cent. Life Sci.; Tel Aviv Univ.; Tel Aviv; Israel)
Laboratory experiments on the effects of crude oil on the Red Sea coral Stylophora pistillata.
Marine Pollution Bulletin, vol. 10, no. 11, p. 328-30, 1979.

Sub-lethal detrimental effects of Iranian crude oil were studied on the hermatypic coral Stylophora pistillata in a long term laboratory experiment. The experimental system consisted of four 1500 l. capacity tanks, two of which were periodically polluted. A significant decrease in the number of female gonads per polyp were recorded in 75% of the

colonies in the polluted tanks. It is concluded that chronic oil pollution damages the reproductive system of scleractinian corals.
Index terms: petroleum Stylophora reprodn Red Sea /Water pollution (by petroleum, in Red Sea, Stylophora pistillata reprodn. response to) / Plant reproduction (by Stylophora pistillata, from Red Sea, petroleum effect on) /Stylophora pistillata (reprodn. by, from Red Sea, petroleum effect on) /Petroleum (reprodn. by Stylophora pistillata from Red Sea response to)

268. Rosewicz, Barbara
Oil could give Iraq ecological weapon, U.S. studies find; blowing Kuwaiti facilities, however, won't change the climate of the Earth.
Wall Street Journal, Jan 25, 1991, col 4, pA4(W) pA5(E).

269. Rosewicz, Barbara
Upping the ante: Gulf oil spill shows Iraq's resolve to wage war on its own terms; largest-ever slick threatens area desalination plants and may hinder allies; Saudis are caught off guard. (Persian Gulf war)
Wall Street Journal, Jan 28, 1991, col 6, pA1(W) pA1(E).

270. Rosewicz, Barbara; Sullivan, Allanna
Jet fuel, diesel refineries could be shut; water supply also threatened. (Persian Gulf war).
Wall Street Journal, Jan 29, 1991, col 4, pA3.

271. **Round-the-world news/Persian Gulf.**
Mar. Pollut. Bull. (United Kingdom), vol. 8, no. 10, Oct 1977.

A draft action plan to protect the marine environment of the area has been agreed upon by eight Persian Gulf countries following a meeting organized by the United Nations Environment Program in Nairobi. Major sections of the plan covered a regional program to assess the environment of the area; management of development activities which have an impact on the protection and use of renewable marine resources; and the development of a legal framework to allow regional cooperation and joint efforts to combat pollution by oil and other harmful substances. A U.N. field mission which recently visited the area confirmed that the potential pollution from activities offshore and onshore is very high. About 100 ships currently enter the sea daily through the Straits of Hormuz, most of them tankers to load at one of the 26 oil terminals. There is congestion at almost every port and the hazards of large accidental oil spills either from tanker collisions or groundings are, therefore, extremely high.|;
Index terms: OIL SPILLS -- HAZARDS/PERSIAN GULF -- ENVIRONMENTAL

QUALITY/ PERSIAN GULF -- WATER POLLUTION ABATEMENT /AQUATIC ECOSYSTEMS/INTERNATIONAL COOPERATION/TANKER SHIPS/UNITED NATIONS / ARABIAN SEA/COOPERATION/ECOSYSTEMS/INDIAN OCEAN/ INTERNATIONAL
ORGANIZATIONS/POLLUTION ABATEMENT/SEAS/SHIPS/SURFACE WATERS

272. Ryan, P.B. (Gulf Area Oil Companies, Mutal Aid Organisation, Manama)
Hasbah 6: Oil companies response to oil pollution in the Arabian Gulf.
1983 Oil Spill Conference - American Petroleum Institute conference on oil spill, Feb 1983.

The Hasbah 6 well offshore Saudi Arabia blew out on October 2, 1980 and remained out of control for ten days. The oil which escaped from the well during this period formed a large slick which drifted southeast down the gulf, threatening the coastal areas of all states south of the blowout site. Oil spill countermeasures were mounted by several oil companies in the region either on their own initiative or upon direction from their respective states' governments in attempts to minimize the adverse effects of the spill. All of the oil companies known to be involved in responding to the oil spill were members of the Gulf Area Oil Companies Mutual Aid Organization (GAOCMAO), an organization formed in 1972 to promote cooperation among oil companies in the Arabian Gulf for oil pollution control and cleanup in the region. The Hasbah 6 incident served to demonstrate the value of GAOCMAO in facilitating cooperative responses by member companies to a common pollution hazard and highlighted many of the problems likely to be encountered in mounting a spill cleanup operation of this magnitude in a restricted and multi-national environment such as the Arabian Gulf.
Index terms: OIL SPILLS -- WATER POLLUTION CONTROL/PERSIAN GULF -- OIL SPILLS/PETROLEUM INDUSTRY -- COOPERATION /BLOWOUTS/OFFSHORE SITES/OIL WELLS/SAUDI ARABIA /ACCIDENTS/ARABIAN SEA/ASIA/CONTROL/INDIAN OCEAN/ INDUSTRY/POLLUTION CONTROL/SEAS/SURFACE WATERS/WELLS

273. Saad, M.A. H. (Alexandria Univ., Dept. of Oceanography, Alexandria, Egypt)
Observations on the problems of pollution in Shatt Al-Arab, Iraq.
Revue Internationale d'Oceanographe Medicale., vol. 18, p. 3-11, 1976.

Shatt-Al-Arab, the confluence of the Trigis and Euphrates Rivers in Southern Iraq and along the border with Iran, carried 35,500 million

cubic meters of water annually into the Persian Gulf and is the Gulf's major pollution source. Oil and oily wastes from hundreds of tankers entering the Shatt for unloading are the major pollution source, but untreated sewaged fed into the confluence from the Iraq city of Basra have covered the bottom with sludge beds, markedly eutrophied the waters, caused bacterial contamination in the aquatic environment, and created a public health danger. Organic matter decomposition is accelerated by the river's water temperatures, which reach 12.8, 21.0, 27.8 and 24.8 centrigrade in winter, spring, summer and autumn, respectively. In addition, the sewage-introduced bacteria in decomposition reduces dissolved oxygen to levels ranging from 3.2 to 1.3 mg/l, with resultant fishkills. Other pollutants entering Shatt Al-Arab directly and through its tributaries are untreated industrial wastes, pesticides and fertilizers. Increasing industrialization and population growth are compounding pollution problems in the Shatt.
Index terms: rivers/water pollution effects/water pollution sources/ foreign countries/oil pollution/pollutants/sewage effluents/ tributaries/decomposing organic matter/dissolved oxygen/industrial wastes/pesticides/agricultural runoff/fertilizers/oil spills/oil wastes/oily water/Shatt al-Arab (Iraq and Iran)/Basra (Iraq)/Persian Gulf/Iraq/Iran

274. Sadiq, M.; T.H. Zaidi, and H. Al-Mohana (Res. Inst.; King Fahd Univ. Pet. Miner.; Dhahran; Saudi Arabia)
Barium bioaccumulation in clams collected from different salinity regimes along the Saudi coast of the Arabian (Persian) Gulf.
Bull. Environ. Contam. Toxicol., vol. 45, no. 3, p. 329-35, 1990.
Index terms: clam contamination barium drilling mud/oil drilling barium pollution Persian Gulf /Meretrix meretrix (barium contamination of, oil well drilling in relation to, on Saudi coast of Persian Gulf) /Drilling fluids and muds (barium hydroxide-contg., barium contamination of clams and sediments from, on Saudi coast of Persian Gulf) /Geological sediments, marine (barium pollution of, oil well drilling in relation to, on Saudi coast of Persian Gulf) /Water pollution (by barium hydroxide-contg. drilling mud, clam and sediment contamination in relation to, on Saudi coast of Persian Gulf)

275. Sadiq, Muhammad (Res. Inst.; King Fahd Univ. Pet. Miner.; Dhahran; Saudi Arabia)
Nickel sorption and speciation in a marine environment.
Hydrobiologia, vol. 176-177, p. 225-32, 1989.
Index terms: sediment pollution nickel Persian Gulf/seawater pollution nickel Persian Gulf/nickel speciation seawater sediment Persian Gulf

/Geological sediments,gulf/Geological sediments, suspended (pollution of, by nickel, speciation and sorption of nickel in, of Persian Gulf)

276. Sadiq, Muhammad, and Ibrahim Alam (Res. Inst.; King Fahd Univ. Pet. Miner.; Dhahran; Saudi Arabia)
Metal concentrations in pearl oyster, Pinctada radiata, collected from Saudi Arabian coast of the Arabian Gulf.
Bull. Environ. Contam. Toxicol., vol. 42, no. 1, p. 111-18, 1989.
Index terms: metal sediment pollution Persian Gulf/Pinctada radiata metal contamination /Water pollution (by heavy metals, sediment and Pinctada radiata contamination in relation to, at Saudi Arabian coast of Persian Gulf) /Pinctada radiata (contamination of, by heavy metals, at Saudi Arabian coast of Persian Gulf) /Geological sediments, coastal

277. Saifullah, S.M.; A.S. Mandura, and A.K. Khafaji (King Abdulaziz Univ., Faculty of Marine Science, Jeddah, Saudi Arabia)
Platymonas bloom in coastal waters of Jeddah, Saudi Arabia.
Pakistan Journal of Botany, vol. 20, no. 2, p. 285-289, Dec. 1983.

A dense green bloom of Platymonas intermedia Nasr observed in coastal waters of Jeddah city (Saudi Arabia) was in close vicinity to the point of discharge of the city's sewage. Cell counts were as high as 38 million cells/L. While carrying out a field trip to south corniche of Jeddah city on November 22, 1986, it was noticed that the coastal waters extending to several hundred meters in length and width were dark green in color instead of the normal blue. The green patches or clouds were swarming in very shallow waters close to the upper water mark. Some 30 to 40 meters further away from the shore, the intensity of the bloom increased the water appeared like a dense green soup. Temperature and salinity values recorded were 29 C and 25 ppt, respectively. Microscopic observations revealed the organisms causing the bloom to be swarms of a green unicellular phytoplankton Platymonas intermedia Nasr. Although many studies have been carried out on marine algae of Saudi Arabia Red Sea waters, none of them ever reported Platymonas from the sea. The bloom was overwhelmingly monospecific showing a count of as many as 37,955,600 cells of P. intermedia per litre. The other species present were extremely rare and negligible. Green flagellates have been reported to form dense blooms elsewhere as well. The cause is not known. However, there is strong evidence that sewage pollution may be the cause of the bloom since most of the domestic sewage of Jeddah city is discharged very close to the point of occurrence of the bloom.
Index terms: water pollution effects/coastal waters/eutrophication/ wastewater outfall/Red Sea/Saudi Arabia/waste disposal/phytoplankton/

wastewater pollution

278. Salihoglu, Ilkay; Mahmut Dogan; Ozden Basturk, and Turguti Balkas
DDT, DDE, and PCB residues in fish, crustaceans and sediments from the Eastern Mediterranean coast of Turkey.
Marine Pollution Bulletin, vol. 11, no. 7, p. 191-?, July 1980.
Index terms: crustaceans/organochlorine residue/marine pollution/DDT/DDE/polychlorinated biphenyls (PCBs)/fish

279. Sasaki, Yasunori; Yoshizumi Yasuda; Ichio Asanuma; Yasufumi Emori; Joji Iisaka, and Kei Muneyama
Satellite thermal observation of oil slicks on the Persian Gulf.
Remote Sensing of Environment, vol. 19, no. 2, p. 171-?, April 1986.
Index terms: oil slick/Persian Gulf/pollution monitoring/remote sensing/satellite/thermal observation

280. **SAUDI DESALINATION PLANT SLOWED BY TOXIC SPILL.**
United Press International, Feb 8, 1991.

281. **SAUDI OFFICIALS DENY OIL SPILL HAS CLOSED DESALINATION PLANT.**
United Press International, Feb 9, 1991.

282. **Saudis fear 'tremendous' damage from Gulf oil slick.**
Japan Economic Newswire, Jan 29, 1991.

283. SAYDAM, C.; I. SALIHOGLU; M. SAKARYA, and A. YILMAZ (Middle East Tech. Univ., Inst. Marine Sci., Erdemli-Icel, Turkey)
Dissolved/dispersed petroleum hydrocarbons suspended sediment, plastic, pelagic tar and other litter in the North-Eastern Mediterranean.
Journees d'etudes sur les pollutions marines en Mediterranee. 7.
Rapp. P.-V. Reun. - Comm. Int. Explor. Sci. Mer Mediterranee, vol. 29, 1985.
Index terms: Pollution/Hydrocarbons/Suspended materials/Sea water/Industrial waste/Oxygen/Environmental geology/East Mediterranean

284. Schmitt, Eric
Winds slowing spread of Gulf oil spill to Saudi water plant. (International Pages) (War in the Gulf)
New York Times, Feb 3, 1991, v140 SECTION 1 col 2, p10(N) p14(L).

285. Schneider, Keith

Pentagon wins waiver of environmental rule. (Department of Defense no longer needs assessments on effect of projects on the environment) (National Pages)
New York Times, Jan 30, 1991, v140 col 1, pA14(N) pA14(L).

286. Schneider, Keith
Saudis seek U.S. help with oil spill. (Persian Gulf) (War in the Gulf).
New York Times, Jan 27, 1991, v140 SECTION 1 col 4, p6(N) p12(L).

287. SCHROEDER, J.H. (Univ. Kiel, Geolog.-Palaeontolog. Inst., Kiel 2300, Federal Republic of Germany)
Die Saumriffe von Port Sudan: II. Gefaehrdung Schutz Entwicklungshilfe Les recifs frangeants de Port Soudan. II. Menaces, protection, aide au developpement The fringing reefs of Port Sudan, Sudan: II. Threats protection development aid.
Essener Symposium zur Kuestenforschung. 1. Essener Geogr. Arb., Paderborn, vol. 6, 1983.
Index terms: Environmental geology/Reefs/Pollution/Conservation/ Protected well zones/Legislation/International cooperation/Red Sea

288. **Scientists debate effects of Gulf-area oil fires on global weather patterns.**
PR Newswire, Jan 23, 1991.

289. SCOTT, G.A. (Arabian American Oil Co, Dhahran, Saudi Arabia)
Oil pollution control equipment and facilities.
Middle East oil show. 4, 1985.
Index terms: Water pollution/Seawater/Persian Gulf/Petroleum/Spill/ Pollution control/Limitation/Recovery/Dispersion/Dispersant/ Occupational training/Organization/Cost estimation/Offshore production

290. Sebastian, J. (Kuwait Inst. Sci. Res., Maricult. and Fish. Dep., P.O. Box 1638, Salmiya 22017, Kuwait)
Nutrient salt sources and water quality of N.W. Arabian Gulf.
EIGHTH INTERNATIONAL OCEAN DISPOSAL SYMPOSIUM, 9-13 OCTOBER 1989,
INTER-UNIVERSITY CENTRE OF POSTGRADUATE STUDIES, DUBROVNIK, YUGOSLAVIA. PROGRAM AND ABSTRACTS.FLORIDA INST. OF TECHNOLOGY,
MELBOURNE, FL (USA), 1989. p. 65

The recent industrialization in the Arabian Gulf countries has increased the use of its coastal seas for waste discharge,

aquaculture, oil transportation and desalination, etc. The dumping of wastes into the intertidal zone has shown signs of adverse impacts on the highly productive coastal ecosystem. Studies on the water quality of the N.W. Arabian Gulf have shown two main sources of nutrients to the water body: (1) the Shattal-Arab River discharging at the north and (2) the nutrient released from the intertidal zone. Seasonal, interannual and spatial variability in the water quality and hydrographic features are discussed.
Index terms: waste disposal/marine pollution/seasonal variations/ eutrophication/ surveys/Persian Gulf/nutrients

291. **SECOND TEAM OF SOVIET RESEARCHERS OFFER HELP TO FIGHT OIL SLICK IN GULF.**
TASS, Feb 8, 1991.

292. Shaban, H.I.; G.A. Al-Enezi, and A. Qadar (Kuwait Univ., Safat Kuwait)
Pollution control in the Gulf Cooperation Council (G.C.C.) countries.
Journal of Environmental Science and Health, Part A: Environmental Science and Engineering (USA), vol. 28, no. 8, 1988.

Results of monitoring studies show that nitrogenous compounds are the most hazardous and are the main pollutants in the coastal waters of the G.C.C. countries. The hydrolyzation plant in industrial wastewater treatment has been selected for study from other pollution control measures existing in the gulf Cooperation Council (G.C.C.) countries. The study was undertaken due to the importance of preserving the quality of coastal waters. Analysis of performance studies has shown that originally designed measures are sometimes inadequate to solve practical pollution problems. However, addition of a small process unit can serve the double fold purpose of ccntrolling environmental pollution of sea water on one hand and to obtain irrigation water and soil conditioner on the other.
Index terms: WASTE WATER -- WATER POLLUTION CONTROL/WATER POLLUTION CONTROL -- INTERNATIONAL COOPERATION /AGRICULTURE/INDUSTRIAL PLANTS/ IRRIGATION/NITROGEN COMPOUNDS/ NITROGEN OXIDES/PERSIAN GULF/SEAWATER/ SOILS/USES/WATER QUALITY /ARABIAN SEA/CHALCOGENIDES/CONTROL/ COOPERATION/ ENVIRONMENTAL QUALITY/HYDROGEN COMPOUNDS/INDIAN OCEAN/ INDUSTRY/ LIQUID WASTES/NITROGEN COMPOUNDS/OXIDES/OXYGEN COMPOUNDS/ POLLUTION CONTROL/SEAS/SURFACE WATERS/WASTES/WATER

293. Shamshoom, S.M.; T.S. Ziara; A.N. Abdul-Ritha, and A.E. Yacoub (Mar. Sci. Cent.; Univ. Basrah; Basrah; Iraq)
Distribution of oil-degrading bacteria in the north-west Arabian (Persian) Gulf.
Mar. Pollut. Bull., vol. 21, no. 1, p. 38-40, 1990.
Index terms: oil degrading bacteria Persian Gulf/seawater sediment oil degrading bacteria/pollution oil bacteria Persian Gulf /Geological sediments,marine/Waters, ocean (oil-degrading bacteria in, in Persian Gulf) /Acinetobacter/Aeromonas/Bacillus/Bacteria/Enterobacter/ Flavobacterium/Pseudomonas/Vibrio (oil-degrading, in seawater and sediment, in Persian Gulf) /Petroleum products,oil spills/Petroleum, oil spills (on seawater, oil degrading bacteria in relation to, in Persian Gulf)

294. Shapiro, Eben
Investors hope to profit from cleanup of Gulf. (oil spill in Persian Gulf; environmental services industry stocks)
New York Times, Jan 29, 1991, v140 col 5, pC7(N) pD7(L).

295. Sheets, Kenneth
Iraq's environmental warfare. (intentional oil spilling)
U.S. News & World Report, Feb 4, 1991, v110 n4, p60(1).

296. Shekel, Yehuda, and Rosa Ravid (Israel Pet. Inst.; Ramat Aviv; Israel)
Sources of tar pollution on Israeli Mediterranean coast.
Environ. Sci. Technol., vol. 11, no. 5, p. 502-5, 1977.
Index terms: tar pollution Mediterranean seawater Israel/petroleum tar pollution Mediterranean/fuel oil tar pollution Mediterranean /Water pollution (by tar balls, in eastern Mediterranean Sea, origin of) / Hydrocarbons,occurrence (in tar balls in seawater of eastern Mediterranean Sea, degree of weathering in relation to) /Petroleum (tar, water pollution by, of eastern Mediterranean Sea) /Fuel oil/Tar, petroleum (water pollution by, of eastern Mediterranean Sea)

297. Shenon, Philip
Another oil spill imperils the Gulf; a 'significant slick' occurs at terminal off Kuwait - its cause is uncertain. (Persian Gulf, Mina al-Bakr oil terminal) (International Pages) (War in the Gulf).
New York Times, Jan 31, 1991, v140 col 6, pA5(N) pA11(L).

298. Shenon, Philip
Aramco ecologist fears oil slick will produce a 'dead Gulf.' (Persian Gulf; Freddy Costello) (War in the Gulf)

New York Times, Feb 9, 1991, v140 col 1, p5(N) p7(L).

299. Shenon, Philip
U.S. bombs Kuwait oil stations, seeking to cut flow into Gulf; more Iraqi planes fly to Iran; huge slick still a threat to Saudi water plants. (oil spill in Persian Gulf; Saudi Arabia; includes war summary)
New York Times, Jan 28, 1991, v140 col 5, pA1(N) pA1(L).

300. SHIBER, J.G. (C/O I.C.S., APARTADO 271, LA CALA, ESTEPONA MALAGA,

SPAIN)
METAL CONCENTRATIONS IN CERTAIN COASTAL ORGANISMS FROM BEIRUT
LEBANON.
HYDROBIOLOGIA, 1981, p. 181-196.

Trace metal concentrations were determined in 6 spp. of intertidal organisms common to the coast of Ras Beirut, Lebanon. Pb, Cd, N, Fe and Zn were highest in the polychaete, Hermodice carunculata but the eggs of the sea urchin, Arbacia lixula, had similar Fe levels and the sea anemone, Actinia equina, had Zn concentrations which also approached levels in the polychaete. The highest Cu occurred in the shore crab, Pachygrapsus transversus, while Cr was highest in the eggs of A. lixula. Cystoseira spinosa, the only alga studied, had average Cu and Fe concentrations similar to those found in the same species in another study. Together with the sea urchin eggs, C. spinosa exhibited the most variable Zn levels in the present investigation. The fish Thalassoma pavo (common along the rocky coastal areas of Lebanon) had fairly high concentrations of certain elements in relation to levels reported in species of fish from other locations. Sewage, garbage, industrial and agricultural waste materials all enter the Mediterranean from Lebanon without prior treatment, which, along with increased land erosion, probably contributes substantially to the availability of metals to the biota studied. Work on trace elements in coastal organisms from the eastern Mediterranean basin should be undertaken before any conclusive statements are made. Physiological and biochemical factors involved in metal uptake and retention by each species should be studied.
Index terms: HERMODICE-CARUNCULATA/ARBACIA-LIXULA/ACTINIA-EQUINA/ PACHYGRAPSUS-TRANSVERSUS/CYSTOSEIRA-SPINOSA/THALASSOMA-PAVO/POLLUTION/ SEWAGE/LEAD/ EROSION/COPPER/EGG/ZINC/NICKEL/MEDITERRANEAN SEA
301. Shiber, J.G. (Shiber Consultants, Safat, Kuwait)

Plastic particle and tar pollution on beaches of Kuwait.
Environ. Pollut., vol. 57, no. 4, p. 341-51, 1989.

Twelve beaches on the northwestern Arabian Gulf coast of Kuwait were surveyed for the occurrence of plastic particles, tar balls, and tar lumps. Particles were found on all beaches and were abundant on four: Suleikhat, Fintas, Fahaheel, and New Al Khiran. Most particles were composed of low-density polyethylene, but a few were of high-density polyethylene, polypropylene, and polystyrene. Many were weathered and had traces of tar. Tar lumps and balls were present on all beaches, but were not as abundant as expected, considering the heavy volume of oil tanker traffic in this region of the Arabian Gulf. Tar appeared to be less abundant than it was in 1979. With at least 33 plastics factories operating on the coast of Kuwait, it is possible that plastic particles occur more abundantly than was observed in this study. The high winds and concurrent wave activity, which often vary in strength and direction, but regularly occur here, probably play an important role in dispersing plastic particles, thus making accurate estimation of abundance difficult.
Index terms: beach plastic tar pollution Kuwait/plastic particle pollution beach Kuwait/tar ball pollution beach Kuwait /Plastics (beach pollution by particles of, of Persian Gulf Coast of Kuwait) / Water pollution (by plastic particles and tar, of Persian Gulf Coast of Kuwait)/Tar, petroleum (pollution by, of Beaches of Persian Gulf Coast of Kuwait)/Beaches (pollution of, by plastic particles and petroleum tar, on Persian Gulf Coast of Kuwait)

302. Shiber, J.G. and Salanki, J. (Shiber Consult., P.O. Box 21643, Safat, Kuwait)

Trace metals in edible crustaceans from Lebanon.
Symposium on Heavy Metals in Water Organisms.
BUDAPEST (HUNGARY) : AKADEMIAI KIADO, 1985. p. 285-298.

The eastern Mediterranean basin has not yet been extensively investigated with regard to contamination of biota by the various pollutants reported to be existent there. Studies by such organisations as Unesco (1977) which have warned about the serious increase in the volume of waste materials, particularly those containing heavy metals, along the Lebanon-Israel/Palestine coast make it clear that work of this nature is needed. In view of this, and despite the ongoing civil war in Lebanon, a number of pilot studies to determine the levels of heavy metals in certain coastal organisms were undertaken there in the late 1970's. The last of these studies included the analysis of two commercially-important deep-water

crustaceans: the large shrimp, Penaeus japonicus Bate, 1888, and the Mediterranean locust lobster, Scyllarides latus Latreille 1803.
Index terms: heavy metals/crustaceans/Lebanon/pollutant detection/ marine pollution

303. SHUNBO, F.; L. AL-HARMI; F. ABDALLY; M. AL-ALI, and P. LITERATHY
The analysis of organic micropollutants in Kuwait's marine environment.
Annual research report-Kuwait Institute for Scientific Research, 1981.
Index terms: Marine sediments/Pollutants/Organic compounds/ Hydrocarbons/Intertidal sedimentation/Kuwait/Persian Gulf/Pollution

304. Shuval, H.I.; A. Thompson; B. Fattal; S. Cymbalista, and Y. Wiener (Hadassah Medical School, Jerusalem, Israel)
Natural virus inactivation processes in sediments.
Journal of the Sanitary Engineering Division, American Society of Civil Engineers., vol. 97, no. SA5, p. 587-600, Oct. 1971.

A study of virus inactivation in seawater revealed biological factors to be the primary mode of inactivation. Enteroviruses were more resistant to natural antiviral activity than coliform organisms. Enteroviruses were detected in polluted coastal areas showing relatively low coliform counts, which suggests further investigation of coliforms as pollution indicator organisms. Fluctuation of physical factors altered the rate of virus inactiviation, and no antiviral elements could be demonstrated without the presence of bacteria.
Index terms: viruses/marine bacteria/self-purification/bioindicators/ analytical techniques/pollutant identification/enteric bacteria/ coliforms/pathogenic bacteria/water pollution/Red Sea/Mediterranean Sea

305. **Sierra Club condemns Persian Gulf oil disaster. (transcript)**
PR Newswire, Jan 25, 1991.

306. **The slick in the war zone. (Persian Gulf)**
Maclean's, April 18, 1983, v96, p33(1).

307. **Source of oil bombed, Iraqi missile raids cease.**
Japan Economic Newswire, Jan 28, 1991.

308. **SOVIET OFFICIAL SAYS GULF OIL SPILL COULD SPELL ECOLOGICAL DISASTER.**
TASS, Feb 8, 1991.

309. **SOVIET SCIENTISTS OFFER NEW METHOD TO CLEAN UP OIL SLICK IN PERSIAN GULF.**
TASS, Feb 8, 1991.

310. **Spill backfires on Iraq. (oil spill shuts down desalting plants in Kuwait) (International Pages) (War in the Gulf).**
New York Times, Feb 5, 1991, v140 col 5, pA5(N) pA13(L).

311. Stammer, Larry B.; Parrish, Michael
Experts not prepared to cope with spill. (oil spill in Persian Gulf) (The Gulf War)
Los Angeles Times, Jan 27, 1991, v110 col 1, pA6.

312. Sultan, S.A. R., and F. Ahmad
Flushing of a coastal lagoon in the Red Sea.
Estuarine, Coastal and Shelf Science, vol. 31, no. 3, p. 345-?, Sept. 1990.
Index terms: water pollution research/flushing/lagoon, coastal/Red Sea

313. THIEL, H. (INST. HYDROBIOL. FISCHEREIWISSENSCHAFT UNIV. HAMBURG, ZEISEWEG 9, D-2000 HAMBURG)
BENTHIC INVESTIGATIONS OF THE DEEP RED SEA CRUISE REPORTS OF R. V. SONNE MESEDA I 1977 AND R. V. VALDIVIA MESEDA II 1979.
COUR FORSCHUNGSINST SENCKENB 1980. p. 1-35.

Industrial activities in marine habitats usually involve some risk of environmental pollution. The Saudi Sudanese Commission for the Exploitation of the Red Sea Resources initiated oceanographical studies related to the proposed mining of metalliferous sediments from the central trough of the Red Sea in depths of about 2000 m. Initial ecological investigations were made in 1977 and in 1979. They included a coral reef survey, plankton and nutrient studies, and research on the deep benthos. The background of the applied studies and the academic implications of the results were discussed. For the benthos studies information is given including maps, station lists, the depth profile around which sampling and photographing concentrated in 1977, and short gear descriptions.
Index terms: CORAL REEF/PLANKTON/POLLUTION/NUTRIENT/SEDIMENT/ PHOTOGRAPHY

314. Thiel, Hjalmar; Horst Weikert, and Ludwig Karbe (Inst. Hydrobiol. Fischereiwiss. Hydrobiolo. Abt.; Univ. Hamburg; D 2000; Hamburg; Fed. Rep. Ger.)
Risk assessment for mining metalliferous muds in the deep Red Sea.

Ambio, vol. 15, no. 1, p. 34-41, 1986.
Index terms: metalliferous mud Red Sea review/risk metalliferous mud mining review /Water pollution (by metalliferous mud deep sea mining, risk assessment of, in Red Sea)

315. Thompson, Mary-Frances
International Conference on Marine Science in the Red Sea: AIBS report. (Am. Inst. of Biol. Sciences)
Bioscience, April 1983, vol. 33, p. 274-279.

316. Thorhaug, Anitra
For that oil spill, dispersants. (Persian Gulf war spill cleanup proposal) (column).
Washington Post, Jan 29, 1991, v114 col 2, pA19.
ARTICLE TYPE: column

317. **Threat of Modern Warefare to Man and his Environment: An Annotated Bibliography.**
Reports and Papers in the Social Sciences, Paris: UNESCO. 1978.
Prepared under the auspices of the International Peace Research Assocation IPRA.

318. **Translations on Environmental Quality. Number 8.**
Arlington, Va. : Joint Publications Research Service, 31 Jan 74. 55 p.

This serial report contains translations from the world press of articles and press commentary on environmental pollution. In this report the following are included: From Czechoslovakia-environmental problems and water conservation; from Hungary-water purification and fly ash control; from Poland-antipollution measures; from Brazil-pollution measured by satellite, destruction of nature, danger to wood areas around Rio de Janerio, and university graduates in ecology; from Columbia-parathion in Columbian Bay; from Mexico-government action against pollution; from Kuwait-Persian Gulf pollution; and from the USSR-responsibility for the environment, water pollution, the antarctic and an interview on ecology.
Index terms: Environments/Pollution/Translations/Czechoslovakia/ Hungary/Poland/Brazil/Columbia/Mexico/Kuwait/USSR/Water pollution/ Ecology/Air pollution/Industrial wastes

319. TRANSLATIONS ON ENVIRONMENTAL QUALITY.
OCT 18, 1974,. no. 59, 32 p.
Report #: NTIS REPORT JPRS-63237.

A DISCUSSION OF POLLUTION PROBLEMS THROUGHOUT THE WORLD COVERS:
POLAND-WATER POLLUTION CONTROL MEASURES; IRAN-A CLEAN AIR ACT THAT WILL BE IMPLEMENTED; KUWAIT-INDUSTRIAL WASTES AND RAW SEWAGE IN ARABIAN GULF WATERS; THE USSR-CEMA COUNCIL INVESTIGATION OF ENVIRONMENTAL PROTECTION METHODS, KHERSONSKAYA OBLAST WATER TREATMENT FACILITIES, BOBRUYSK CLEAN-UP MEASURES, AND NOISE ABATEMENT PROGRESS IN ESTONIA.
Index terms: ENV PROGRAMS, NON U S /POLAND /WATER POLLUTION CONTROL /IRAN / LAW, ENV-NON U S /KUWAIT /USSR /SEWAGE DISPOSAL /PERSIAN GULF / USSR /COUNCIL MUTUAL ECON ASSIST /WATER PURIFICATION /ESTONIA / NOISE POLLUTION CONTROL

320. Tumulty, Karen
Environmental weapon used before. (Soviet Union's "ecological weapons"; includes background information) (The Gulf War)
Los Angeles Times, Jan 29, 1991, v110 col 3, pA6.

321. UNESCO/ROMPE/UNEP.
Combatting oil pollution in the Kuwait Action Plan region.
1985. (UNEP regional seas reports and studies ; no. 44)

322. United Nations Environmental Programme.
Action plan for the protection of the marine environment and the coastal areas of Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.
1983. (UNEP regional seas reports and studies ; no. 36)

323. University of York. Coral Reef and Tropical Marine Research Unit.
Management of critical habitats on the Arabian Gulf Coast of Saudi Arabia.
York, U.K. : The Unit, 1982.
Report to MEPA by the Coral Reef and Tropical Marine Research Unit, University of York.

324. **U.S. says flow from Sea Is. has stopped. (Sea Island terminal off-shore Kuwait).**
Platt's Oilgram News, Jan 30, 1991, v69 n21, p1(2).

325. **U.S. attack stops flow of oil into gulf; threat to Jubail complex seen. (Jubail refinery and petrochemical complex) (Cover Story).**
Platt's Oilgram News, Jan 29, 1991, v69 n20, p1(2).
ARTICLE TYPE: Cover Story

326. **U.S. raps Iraq's oil spill as "environmental terrorism".**

Japan Economic Newswire, Jan 26, 1991.

327. **U.S. to send experts on oil cleanup mission to Gulf. (Persian Gulf)** Japan Economic Newswire, Jan 27, 1991.

328. **U.S. warplanes bomb oil pumps to stem Gulf spill. (Persian Gulf).** Japan Economic Newswire, Jan 28, 1991.

329. van Oudenhoven, J.A. C.M (Shell Internationale Petroleum Mij, The Hague.)
The Hasbah 6 (Saudi Arabia) blowout: The effects of an international oil spill as experienced in Qatar.
1983 Oil Spill Conference: American Petroleum Institute conference on oil spill, Feb 1983.

An oil well blowout in the Gulf lasted only eight days; however, the resultant oil spill threatened neighboring coasts for as long as two months. On windy days, nearly neutrally buoyant oil slicks approaching the Qatar coasts seemed to disappear, but they soon surfaced again whenever the weather improved. Qatar, suddenly faced with a very unusual spill, did not have an oil spill response plan. Throughout the emergency, therefore, valuable time was lost discussing the appropriate measures and setting protection priorities. Often, any understanding of the nature of the problems involved was lacking. Although most beaches became covered with the tar-like substance, a small task force from the state oil company, supported by a few foreign advisers, was able to protect all the important water intakes. Examples are given of how general principles were adapted to the specific local circumstances; for instance, lagoons were used to trap and handle the oil, and discarded SBM hoses served as breakwaters. To ensure an environmentally responsible cleaning operation, the few personnel available were provided with lists of "do's and don'ts." The effectiveness of various approaches to dispose of collected oil is discussed. A framework for an oil spill contingency plan for Qatar has been developed and a government environmental committee set up. The oil companies' mutual aid organization, put to the test, revealed weak areas, such as transboundary and communication problems, forcing the partners to review the organization. To enhance in-house response, the state oil company purchased spill-response equipment and is considering hands-on training of emergency crews. The valuable experience gained during this emergency should be used to improve future spill preparedness.
Index terms: BLOWOUTS -- ENVIRONMENTAL EFFECTS/OIL SPILLS -- CLEANING/

OIL SPILLS -- ENVIRONMENTAL EFFECTS/PERSIAN GULF -- OIL SPILLS/ QATAR -- LAND POLLUTION CONTROL /OFFSHORE PLATFORMS/OIL WELLS/SAUDI ARABIA/ SHORES/WATER POLLUTION CONTROL /ACCIDENTS/ARABIAN SEA/ASIA/CONTROL/ INDIAN OCEAN/ MIDDLE EAST/POLLUTION CONTROL/SEAS/SURFACE WATERS/WELLS

330. Varnavas, S.P., and G. Papatheodorou (Univ. Patras; Patras; Greece)
Marine mineral resources in the eastern Mediterranean Sea. I. An iron, titanium, chromium, and nickel deposit in the Gulf of Corinth, Greece.
Mar. Min., vol. 6, no. 1, p. 37-70, 1987.
Index terms: iron ore mud slurry Greece/titanium ore mud slurry Greece/chromium ore mud slurry Greece/nickel ore mud slurry Greece/ore bauxite mud slurry Greece/water pollution ore formation Greece / Chromium ores,iron-nickel-titanium-/Iron ores,chromium-nickel-titanium-,preparation/Nickel ores,chromium-iron-titanium-/Titanium ores,chromium-iron-nickel-(formation of, from discharge of bauxitic red mud slurry, of Gulf of Corinth, Greece) /Water pollution (from alumina processing plant, iron-titanium-chromium-nickel ore foramtion in relation to, of Gulf of Corinth, Greece) /Trace elements,occurrence (in metalliferous mud and assocd. sediments, from alumina processing plant discharge, ore formation in relation to, of Gulf of Corinth, Greece) /Geological sediments/Mud (metalliferous, from alumina processing plant discharge, ore formation in relation to, of Gulf of Corinth, Greece)

331. **VOLUNTEERS SOUGHT TO SCRUB ANIMALS FOULED BY PERSIAN GULF OIL SLICK** United Press International, Feb 1, 1991.

332. Wald, Matthew L.
Currents, not man, will decide the spill's effects. (Persian Gulf oil spill) (International Pages) (War in the Gulf).
New York Times, Jan 29, 1991, v140 col 3, pA5(N) pA11(L).

333. Walgate, R.
Gulf pollution--UN's other worry.
Nature, vol. 287, no. 5782, p. 477, Oct. 1980.

The United Nations Environment Programme will assist countries in the Gulf of Kuwait area with planning and research into the sources and effects of pollutants in this fragile water supply. This body of water averages only 35 meters deep, and evaporates more water than it received from river runoff. Little basic information exists of the

Gulf's oceanography, ecology, and meteorology. Although these waters are needed for drinking, agriculture, and industry, they are exposed to many pollutants--heavy metals, noxious gases, oils, municipal sewage, and airborne dust. The institutions and equipment for pollution control have lagged behind the rapid population and industrial development. Hence, the need for research is great.
Index terms: United Nations/oil pollution/Kuwait/water pollution/ Persian Gulf/sewage/water resources/industrial wastes/air pollution/ pollutants/water quality/Iraq/Iran

334. **Water treatment contract for the Persian Gulf.**
Int. Pet. Times (United Kingdom), vol. 82, p. 2082, 1 Sep 1978.

Serck Water Processing has completed a 200,000 pound sterling tanker ballast water treating plant contract for Sofiran's crude oil processing complex now under construction in Iran. The plant, which uses the Hiperfilter filtration scheme, is designed for tankers with a turnaround of ten days and will have a throughput of 250 cu m/hr. Tanker ballast water containing approx. 100 mg/l. of crude will be discharged into a 90,000 cu m tank at the terminal prior to loading, treated by a tilted plate separator, which operates on the density difference between oil and water and which uses parallel corrugated plates to allow smooth linear flow and oil globule separation up to 50 mg/l. The separated oil is then removed by an adjustable skimmer and returned to the oil processing plant via positive displacement pumps and meters. The water is forced through a bank of Hiperfilters at a working pressure of 8 bars; the filter beds are kept clean by an air scour. During filter backwash, which can be initiated either automatically or manually, the other three filters take the load. The effluent water from the Hiperfilters will have less than 15 mg/l. of crude and no suspended solids larger than 10j dia.
Index terms: PERSIAN GULF -- WATER POLLUTION CONTROL/WATER POLLUTION CONTROL -- POLLUTION CONTROL EQUIPMENT /IRAN/PETROLEUM/SEPARATION PROCESSES/SKIMMERS/TANKER SHIPS/ TRANSPORT/WASTE PROCESSING/WATER POLLUTION /ARABIAN SEA/ASIA/CONTROL/DEVELOPING COUNTRIES/ ENERGY SOURCES/EQUIPMENT/FOSSIL FUELS/FUELS/INDIAN OCEAN/ PROCESSING/SEAS/SHIPS/SURFACE WATERS/WASTE MANAGEMENT

335. WCMC.
Draft list of protected areas with mangrove habitats.
1991.
Unpublished report.

336. Whaley, Michael; Renato Garcia, and Jaime Sy (Amartech Ltd.; Yanbu Al-Sinaiyah; Saudi Arabia)
Acute bioassays with benthic macroinvertebrates conducted in situ.
Bull. Environ. Contam. Toxicol., vol. 43, no. 4, p. 570-5, 1989.
Index terms: pollution benthic macroinvertebrate Red Sea/benthic macroinvertebrate bioassay Saudi Arabia/bioassay benthos petrochem complex discharge/petrochem wastewater pollution benthic macroinvertebrate/Water pollution (by petrochem. refinery effluent, of seawater, benthos response to, in vicinity of Yanbu Al-Sinaiyah, Saudi Arabia)/Annelid/Arthropod/Benthos(aquatic organism)/Echinoderm/ Mollusk/Nematode (petrochem. refinery effluent pollution effect on, in vicinity of Yanbu Al-Sinaiyah, Saudi Arabia) /Petroleum refining (wastewater from, seawater pollution by, benthic population response to, in vicinity of Yanbu Al-Sinaiyah, Saudi Arabia)

337. Whelan, Rowena
World Bank fears ecology fund may lose to Gulf aid. (Persian Gulf region).
Reuters Newswire, Sept 21, 1990.

338. WHITEHEAD, N.E.; VAUGELASJ. DE; P. PARSI, and M.C. NAVARRO (Musee oceanographique, Monaco Ville 98000, Monaco)
Preliminary study of uranium and thorium redistribution in Callichirus laurae burrows, Gulf of Aqaba (Red Sea).
Oceanologica Acta, vol. 11, 1988.
Index terms: Radioisotope/Biological accumulation/Red Sea/Decapoda/ Burrower/Burrow/Uranium/Thorium/Radioactive pollution/Marine environment/Radioisotope/

339. Worden, Edward
Facilities said safe from oil. (Saudi Basie Industries Corp.; Persian Gulf oil spill)
American Metal Market, Jan 30, 1991, v99 n19, p2(2).

340. **WWF warns of long-term damage from Gulf oil 'ecocide'. (World Wide Fund for Nature)**
Japan Economic Newswire, Jan 28, 1991.

341. Yannai, S., and K. Sachs (Technion-Israel Inst. of Tech., Haifa, Israel)
Mercury compounds in some eastern Mediterranean fishes, invertebrates, and their habitats.
Environ. Res. (United States), vol. 16, 1978.

V. Data Distribution Plots

The following data distribution plots illustrate historical data held by the National Oceanographic Data Center (NODC). The physical/chemical data types include:

1. Oceanographic Station Data - physical/chemical oceanographic data recorded at discrete depth levels. The principal measure parameters are temperature and salinity, but dissolved oxygen, phosphate, total phosphorus, silicate, nitrate, nitrite, and pH may be recorded. Meteorological conditions at the time of cast (e.g. air temperature and pressure, wind, waves) may be reported, as well as auxiliary data such as water color (Forel-Ule scale), water transparency (Secchi disk depth), and depth to bottom. Values of density (sigma-t), sound velocity, and dynamic depth anomaly are computed from measured parameters.

2. High Resolution CTD/STD Data - high-resolution oceanographic data collected using CTD (conductivity-temperature-depth) and STD (salinity-temperature-depth). As they are lowered and raised in the oceans, these electronic devices provide nearly continuous profiles of temperature, salinity, and other parameters. Environmental data at the time of the cast (meteorological and sea surface conditions) may be reported. The data record comprises values of temperature, salinity or conductivity, density (computed sigma-t), and possibly dissolved oxygen or transmissivity at specified depth or pressure levels.

3. Mechanical Bathythermograph Data - temperature-depth profile data obtained using the mechanical bathythermograph (MBT) instrument. The data record comprises pairs of temperature-depth values. Temperature data in this file are recorded at uniform 5 m depth intervals.

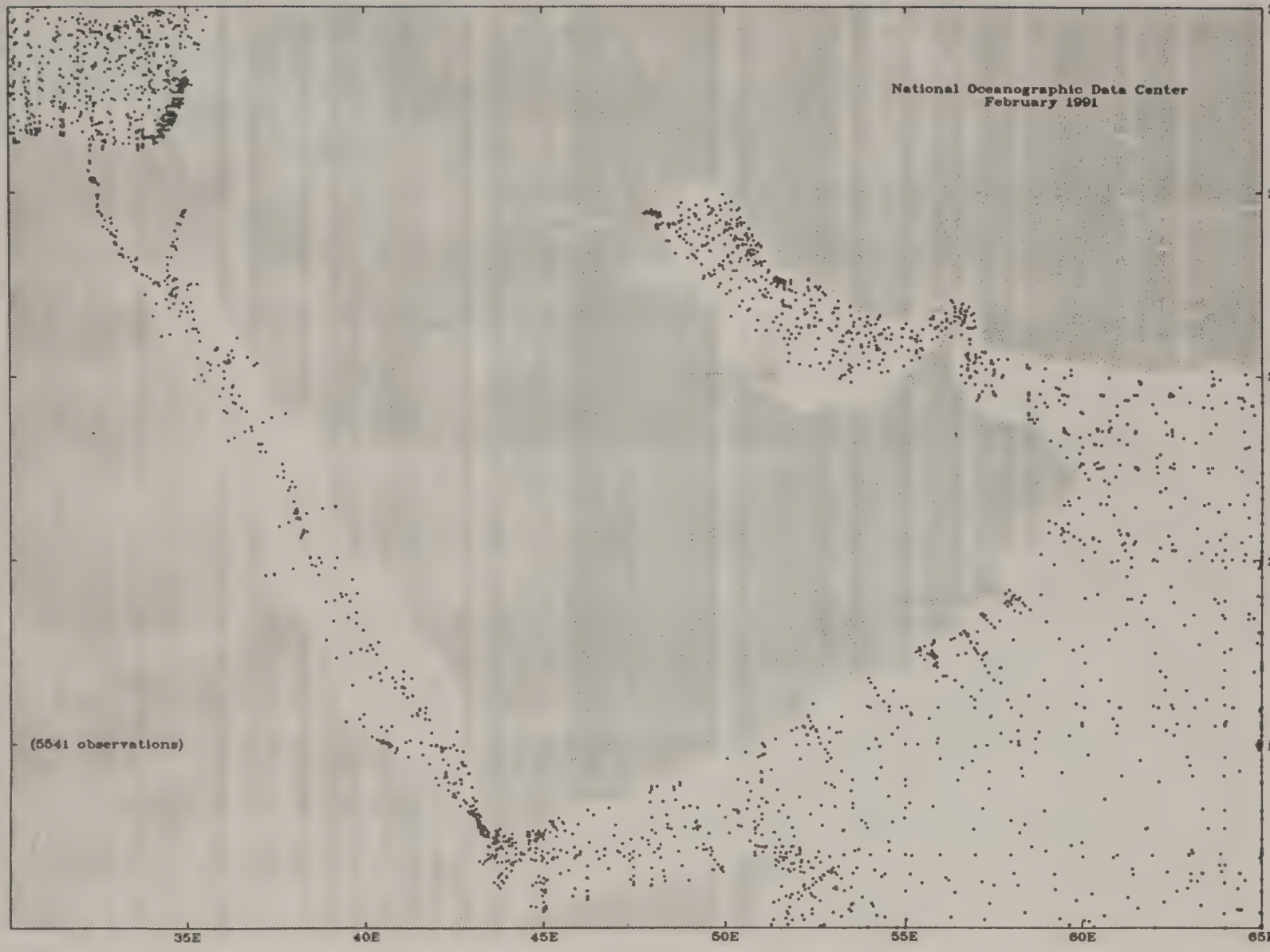
4. Expendable Bathythermograph Data - temperature-depth profile data obtained using expendable bathythermograph (XBT) instruments and submitted to NODC in analog (strip chart) or digital form. Unlike the MBT Data File, the XBT Data File contains temperature values at non-uniform depths.

5. Selected Depth Bathythermograph Data - temperature-depth

profile data, principally XBT, submitted to NODC at originator-defined selected depths.

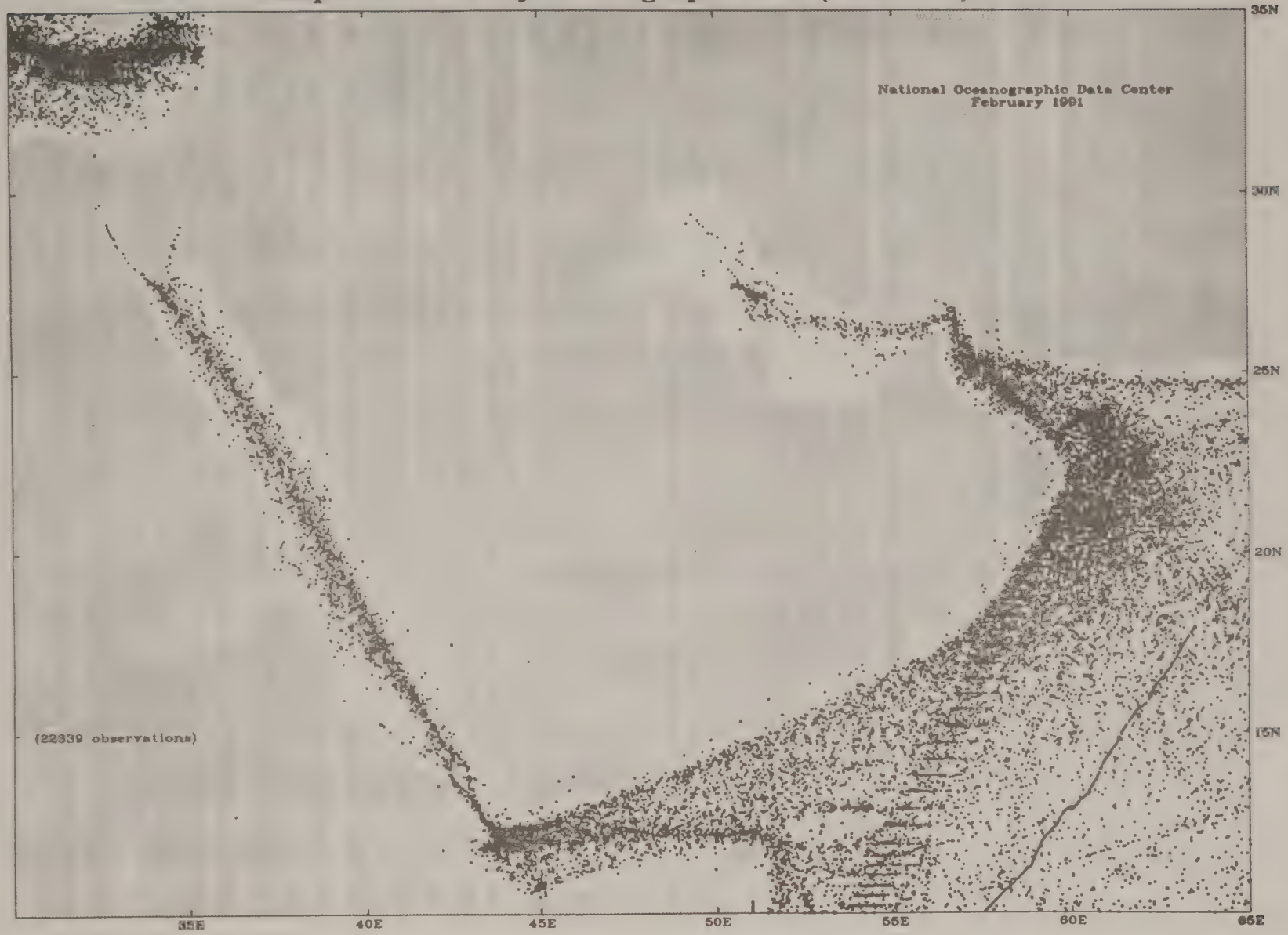
6. Radio Message Bathythermograph Data - temperature-depth profile data (principally XBT) telecommunicated by ships at sea over the Global Telecommunications System in the Integrated Global Ocean Services System (IGOSS) BATHY format.

Oceanographic Station Data (1900–1987)

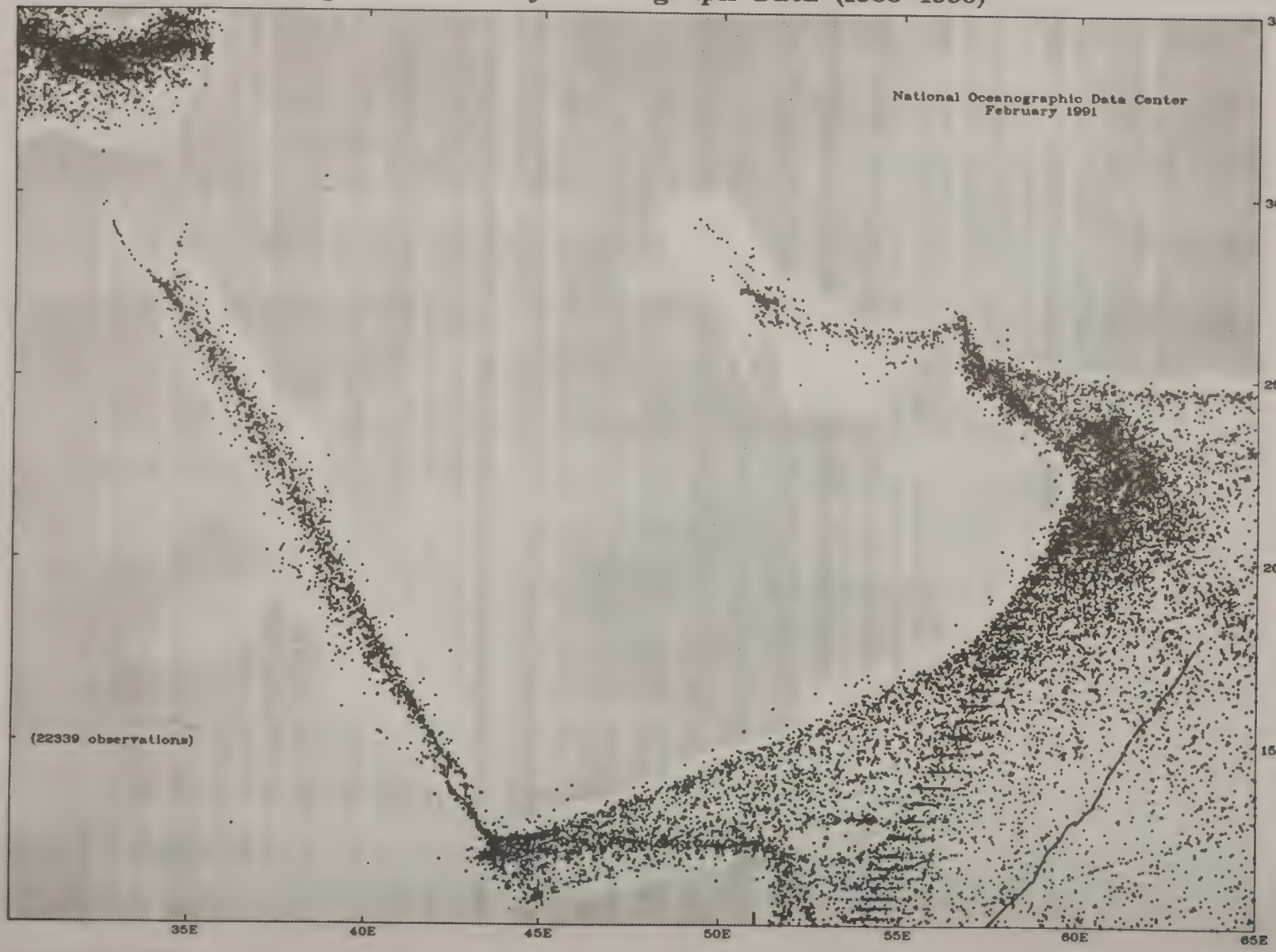


Oceanographic Station Data (1900–1987)

Expendable Bathythermograph Data (1966–1990)

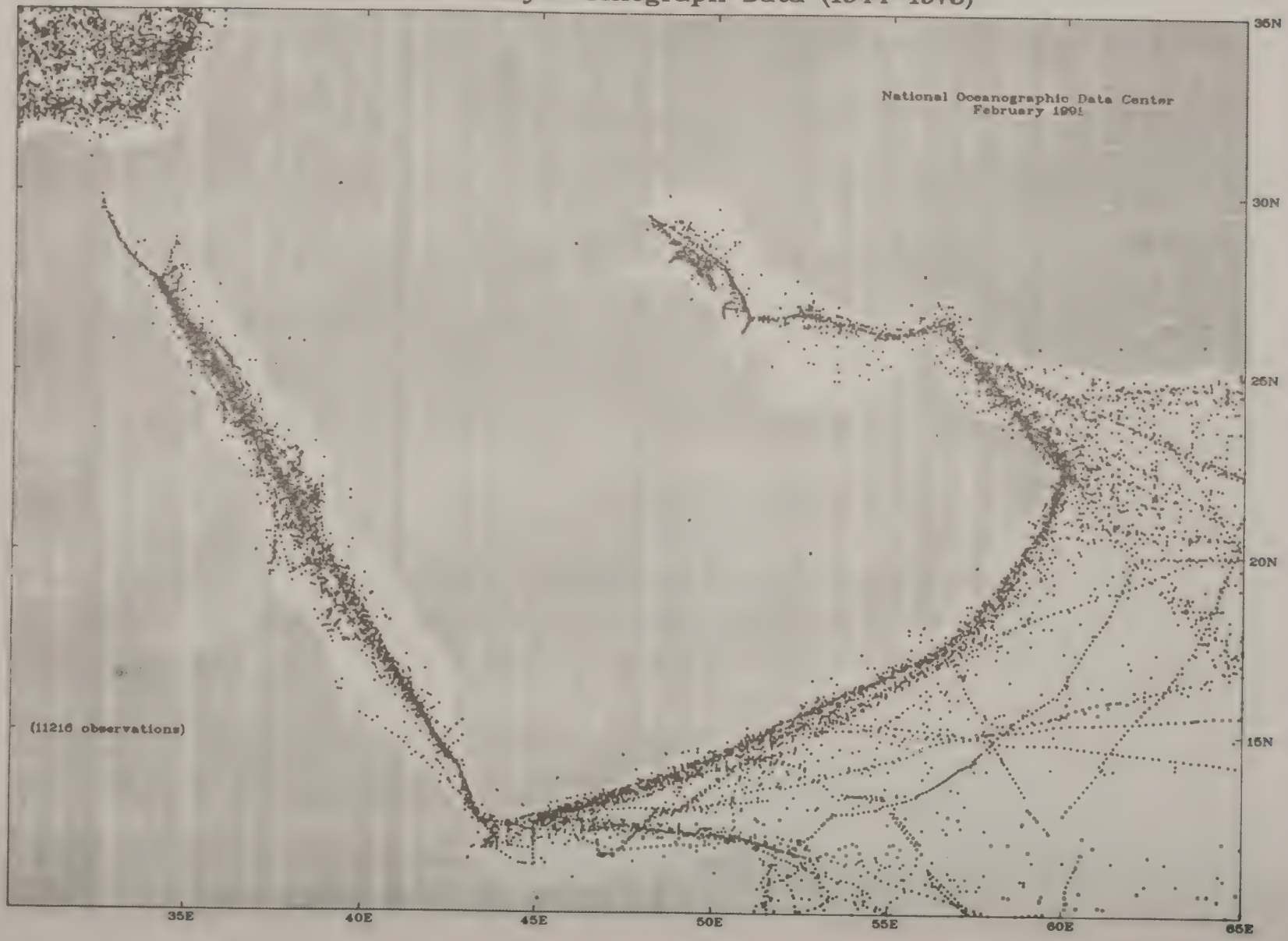


Expendable Bathythermograph Data (1966–1990)

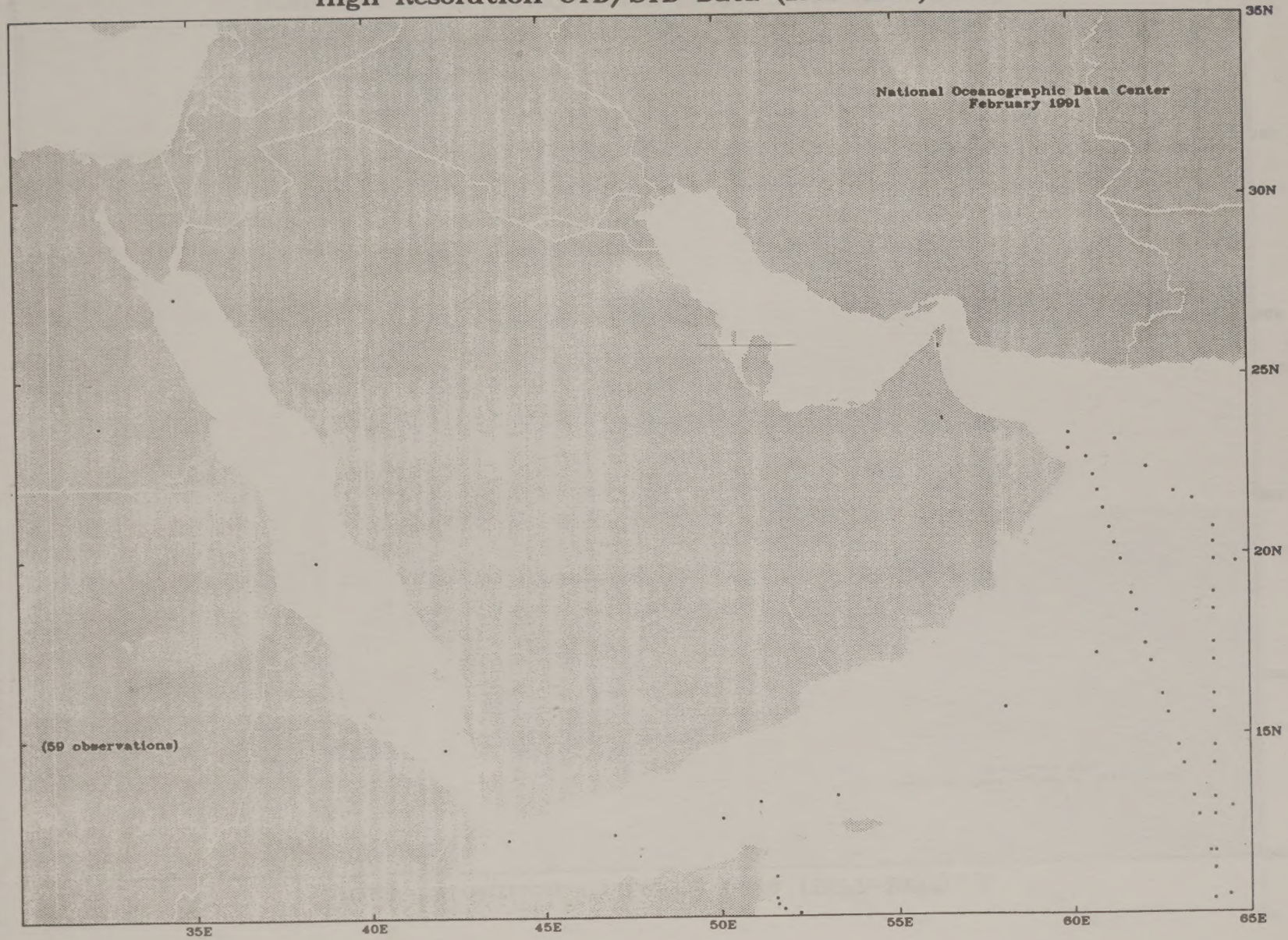


Mechanical Bathythermograph Data (1944–1975)
National Oceanographic Data Center
February 1991
(11216 observations)
35N
30N
25N
20N
15N
35E
40E
45E
50E
55E
60E
65E

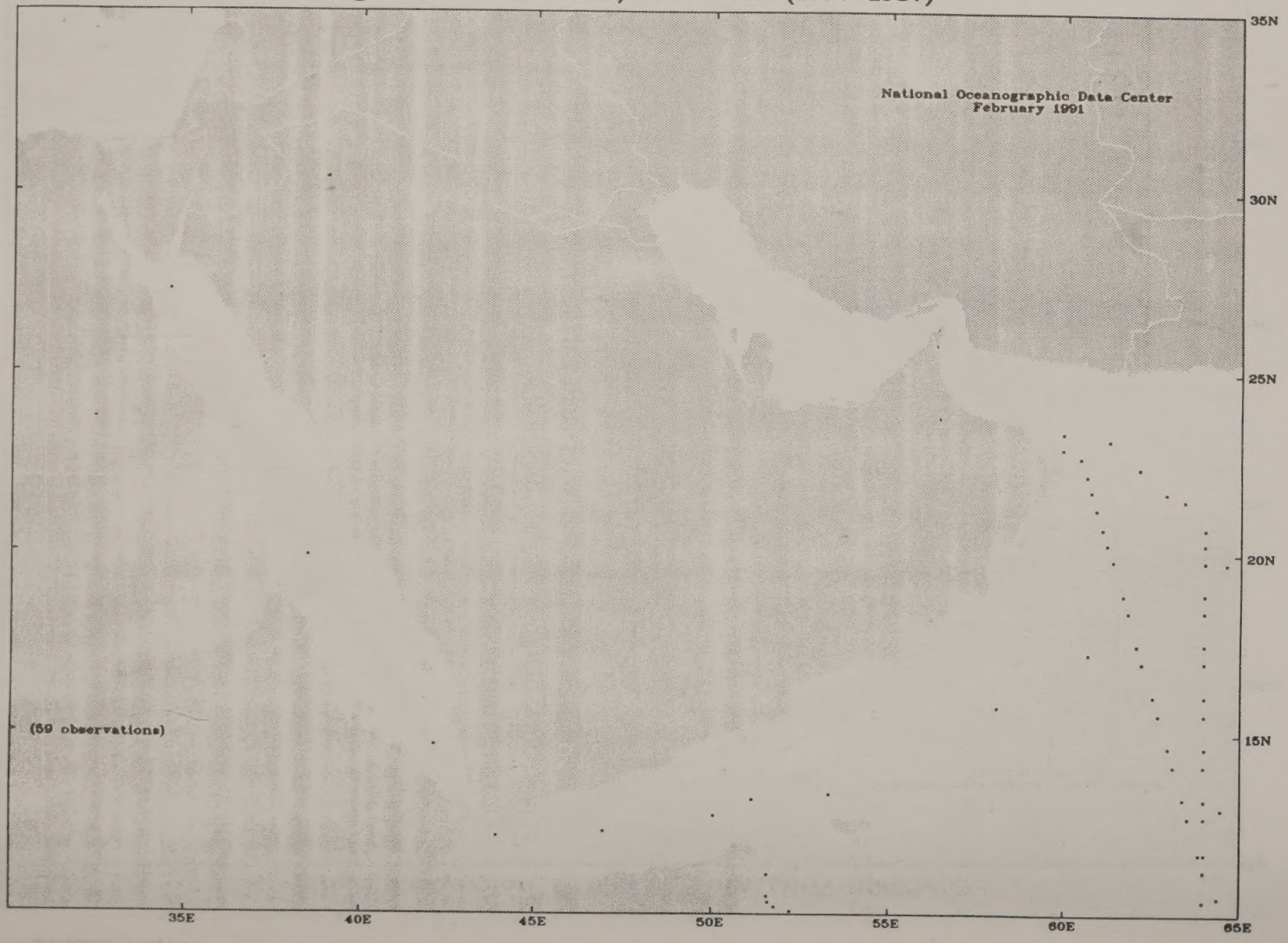
Mechanical Bathythermograph Data (1944–1975)



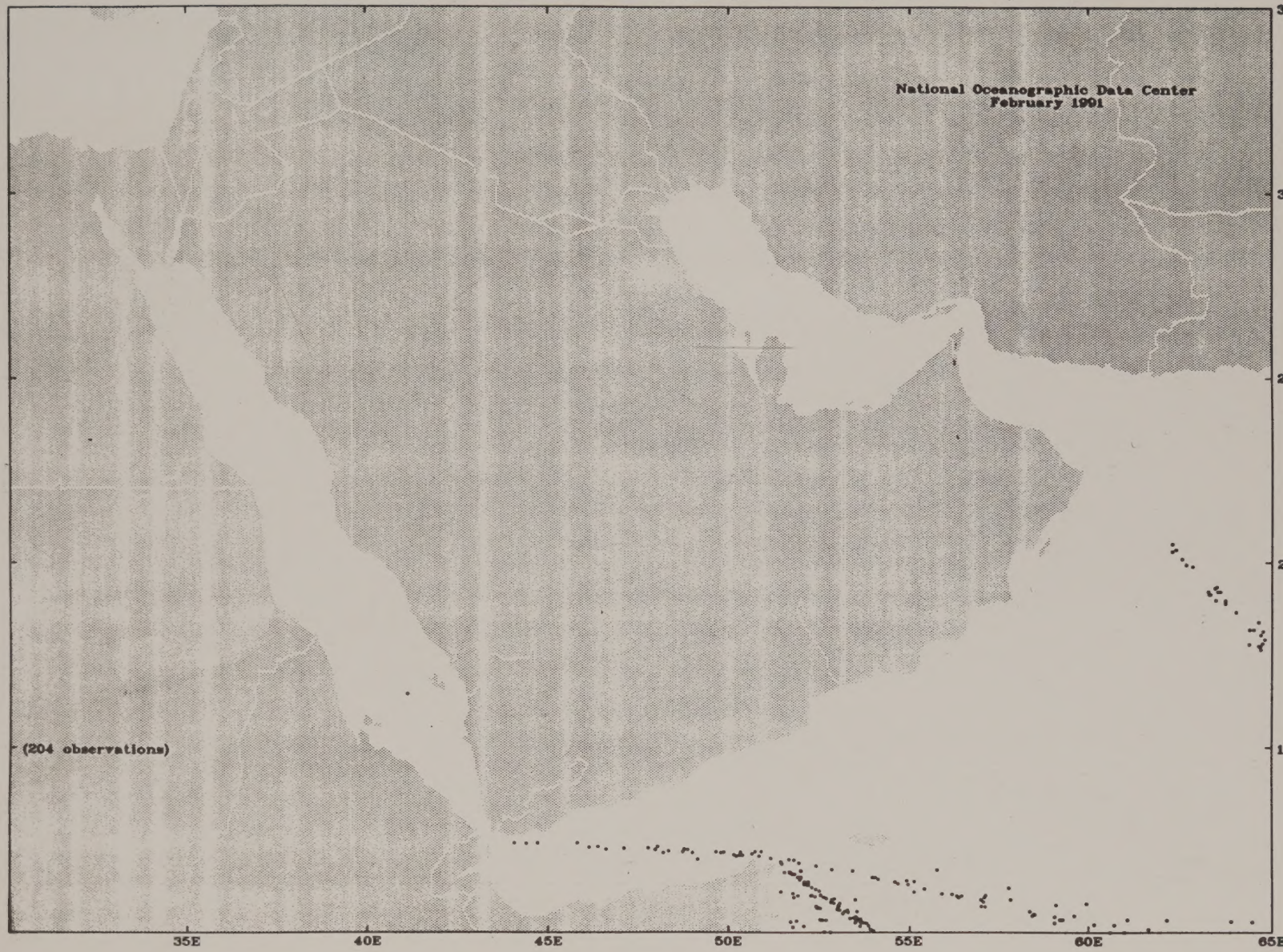
High Resolution CTD/STD Data (1977–1987)



High Resolution CTD/STD Data (1977–1987)



Standard Level Bathythermograph Data (1969–1989)



☆ U.S. GOVERNMENT PRINTING OFFICE: 1991 — 281-559/40648